TABLE OF CONTENTS

AN INVESTIGATION OF THE ESTABLISHMENT AND OPERATION OF MENTAL SETS

by

Hulda J. Rees and Harold E. Israel

Evidence from a variety of experimental fields seems to demonstrate rather conclusively that one of the most significant determinants of an individual's response to a situation is a factor which has been variously termed "preparatory set," "attitude," "readiness," "determining tendency," and "mental set." Especially in studies of thinking and problem-solving has the importance of the subject's "set" toward the problem-situation been shown to be of paramount importance. The experiments which we shall report represent a preliminary attempt at the investigation of some of the factors involved in the establishment of mental sets and of the influences which certain sets may have on the solution of very simple verbal problems.

All of the concepts listed above have been defined somewhat differently by the various writers who use them, but they seem all to refer, broadly, to the general fact that *directedness* appears as a prominent feature of thinking and behavior. This direction may be a consequence of experimental instructions or it may emerge from the subject's interpretation of the properties of the task itself. In any case, the direction will serve to steer the course of thinking toward a particular channel, to color the character of the thought-processes, and to limit the ultimate possibilities of response. The term "mental set," as used here, will refer only to this general concept of direction; it is meant to carry no implication that the sets will operate always at a conscious level or will be identifiable by means of the subject's introspections.

The present study was designed to investigate the establishment of sets by various means and to measure directly their effects upon response. The problem-material consisted of five-letter

anagrams. Some of these were "ambiguous" in the sense that they provided alternative solutions. Others were "non-ambiguous" in that only one solution was possible; these will be termed throughout "simple" anagrams. With the ambiguous items the occurrence of one rather than the other of the alternative solutions provided a means of testing the influence of previously established sets toward a certain type of solution-word or toward a certain method of attack. By the use of groups of subjects for whom different set-conditions were operative it became possible to measure the effects of sets upon the character of the response itself, thus obviating the necessity of complete reliance upon individual introspections.

Experimental investigations of the effects of set on the solution of problems similar in nature and difficulty to those which we have employed are disappointingly few.[1] Starch (10), Foster and Tinker (3), and Langfeld and Allport (7) used material similar to ours, but their experiments were all designed not as research problems but for the purpose of demonstration in teaching.

Starch (10) includes in his laboratory manual an experiment on the influence of set on the completion of skeleton-words. Ten series of skeleton-words are presented to the subject with instructions to work as rapidly as possible. Two of the series are miscellaneous nouns; the other series are "names of articles of dress," "names of fruits," etc. The subject is instructed at the beginning of each series as to its nature. The results for 28 subjects show that an average time score for the completion of the series of unrelated nouns is 75 sec., while for the homogeneous series the average time is 36 sec. Starch gives no further analysis of the data. He remarks that "the meanings of the skeleton-words are in accord with the particular set of associations present. This point is demonstrated by the fact that twenty-two skeletons are alike. Yet in each group a different meaning arises according to the set of the mind." Whether or not the *first* meanings given the skeleton-words in the homogeneous series are invariably in accordance with the established sets is not reported.

Foster and Tinker (3) outline a slightly different experiment on the influence of set on the completion of skeleton-words. Two out of six series of skeleton-

[1] In general, very little research has been directed specifically at the investigation of the effects of set on problem-solution of any sort, the facts which we possess being derived largely as by-products from studies whose major emphases have been on other aspects of productive thought [see, *e.g.*, Heidbreder (5), Maier (9), and Duncker (2)]. The major part of the work on sets or determining tendencies has tended to be centered within the field of reproduction and recall [*e.g.*, Ach (1) and Lewin (8)] where the issue has been largely one of the relative importance of "association" and "attitudes" or "demands" as determining factors. A discussion of the history of this problem and its theoretical and systematic implications does not seem to be pertinent to our problem at the present stage of investigation.

words are presented to the subject with instructions to set himself to complete the skeletons as adjectives. No definite set is given for the other four series. The average median time score of 50 subjects for adjective responses in the series with indefinite set is 3.5 sec., whereas for the words in the series where a definite set for adjectives is given, the score is 2 sec. This increase in speed of response under conditions of a definite set occurs for 85 per cent of the subjects. Again, as in Starch's experiment, no report is given as to the number of responses which are not in congruence with the prescribed set.

From another part of the experiment described in Foster and Tinker's laboratory manual (Experiment 4) came the suggestion for the use of anagrams as problem-material in the present experiments. Six series of five-letter anagrams are solved by the subject. Two of the series, containing miscellaneous words, are presented with an indefinite set (merely to find any word which utilizes all the letters and no more). The other four series are made from words "having to do with eating" or from words which "represent things about the house." The subject is instructed at the beginning of these series to find "eating-" or "house-words." Foster and Tinker report that "a typical median time for transposing anagrams with indefinite set is 25 sec.; for transposing anagrams referring to 'eating,' 10 sec.; for anagrams referring to 'house,' 10 sec." The number of subjects on whose data these calculations are based is not reported.

Langfeld and Allport (7) describe a laboratory demonstration in which the subject is presented with three lists of seven anagrams each. The words in the first list are unrelated; in the second, they all belong to the same category, *e.g.,* articles found in a schoolroom; the third list contains words related to one of the leading interests of the subject, *e.g.,* tennis, music, etc. The subject is not told the category of either the second or the third list. While no results are reported, apparently the expected effect is an increase in speed of solution for the lists containing related words. The interesting feature of this experiment is that the sets for the second and third lists are expected to develop out of the solution of the anagrams themselves.

All of these experiments place their emphasis upon the speed of problem-solution under conditions of definite and indefinite set. Our experiments, on the other hand, emphasize the determination of the character of the response itself through the operation of certain definite sets.

Experiment I

The Effectiveness of Specific Sets Established by Instructions[2]

Foster and Tinker's laboratory demonstration shows effectively that the speed of solution of simple anagrams is increased if the subject is given in advance the set which is congruent with the possibilities of the material. This experiment leaves

[2] The writers are indebted to Elsa M. Siipola for the design of this experiment and for permission to use the results.

untouched, however, the question of the effect which a mental set may have in determining which solution-word will be obtained if more than one is possible. Utilizing specific sets of the same type as those of Foster and Tinker, our first experiments were devised with a view to investigating the influence of the sets upon the meaning-character of the solution-words obtained. Our method rested upon the provision of ambiguous anagrams, only one of whose possible solutions was congruent with a given set.[3]

The experiment was carried out in seven laboratory sections of an elementary course in psychology. The subjects had no knowledge of the purpose of the experiment. The class was divided into groups of two, each student acting alternately as *S* and *E*. All subjects were required to solve at least five anagrams as practice before beginning the experiment proper.

The order of procedure follows:[4]

Subject I. 20 ambiguous anagrams (Series AE) including 10 with possible "eating-solution."
Instructions: "Solve the anagrams."

Subject II. 20 ambiguous anagrams (Series AN) including 10 with possible "nature-solution."
Instructions: "Solve the anagrams."

Subject I. 20 ambiguous anagrams (Series BE), *all* with possible "eating-solution."
Instructions: "Look for 'eating-words'; however, if other words are discovered, report them and they will be credited."

Subject II. 20 ambiguous anagrams (Series BN), *all* with possible "nature-solution."
Instructions: "Look for 'nature-words'; however, if other words are discovered, report them and they will be credited."

The anagrams were typed in lower-case letters and presented singly by employing a cardboard strip with a small window. For the series given under indefinite set the critical items (those with possible "eating-" and "nature-solutions" in Series AE and AN) were scattered among the other anagrams in the series to avoid the establishment of sets through mere succession. *S* was not allowed to use pencil except for recording her solutions. *S* was required to continue on each item until a solution fitting the mechanical requirements was

[3] Ambiguous anagrams have been used as material in a demonstration of Kline and Kline's (6) on "the effects of changes in meaning on changes in attitude." The subject is told, for example, to rearrange mentally the anagram *ahecp* "so as to spell the name of a fruit." Having obtained the solution, he is then instructed to rearrange the letters "so as to spell an adjective describing a low-priced article." The purpose of this demonstration seems to be that of obtaining a description of the conscious experience during solution. The experiment is of interest here only because of the similarity of the problem-material.

[4] All of the lists of anagrams used in the various experiments are included at the end of this article.

obtained or until 90 sec. had elapsed. At the end of 90 sec., *S* was required to leave the item and go on to the following one. *E* was provided with a complete list of possible solutions from which she judged the correctness of each response. *E* also timed each solution.

Data from 182 subjects demonstrate conclusively that the instructions to look for words of a certain category had the effect of greatly increasing the percentage of such words obtained as solutions. In terms of averages, the percentages of "nature-"

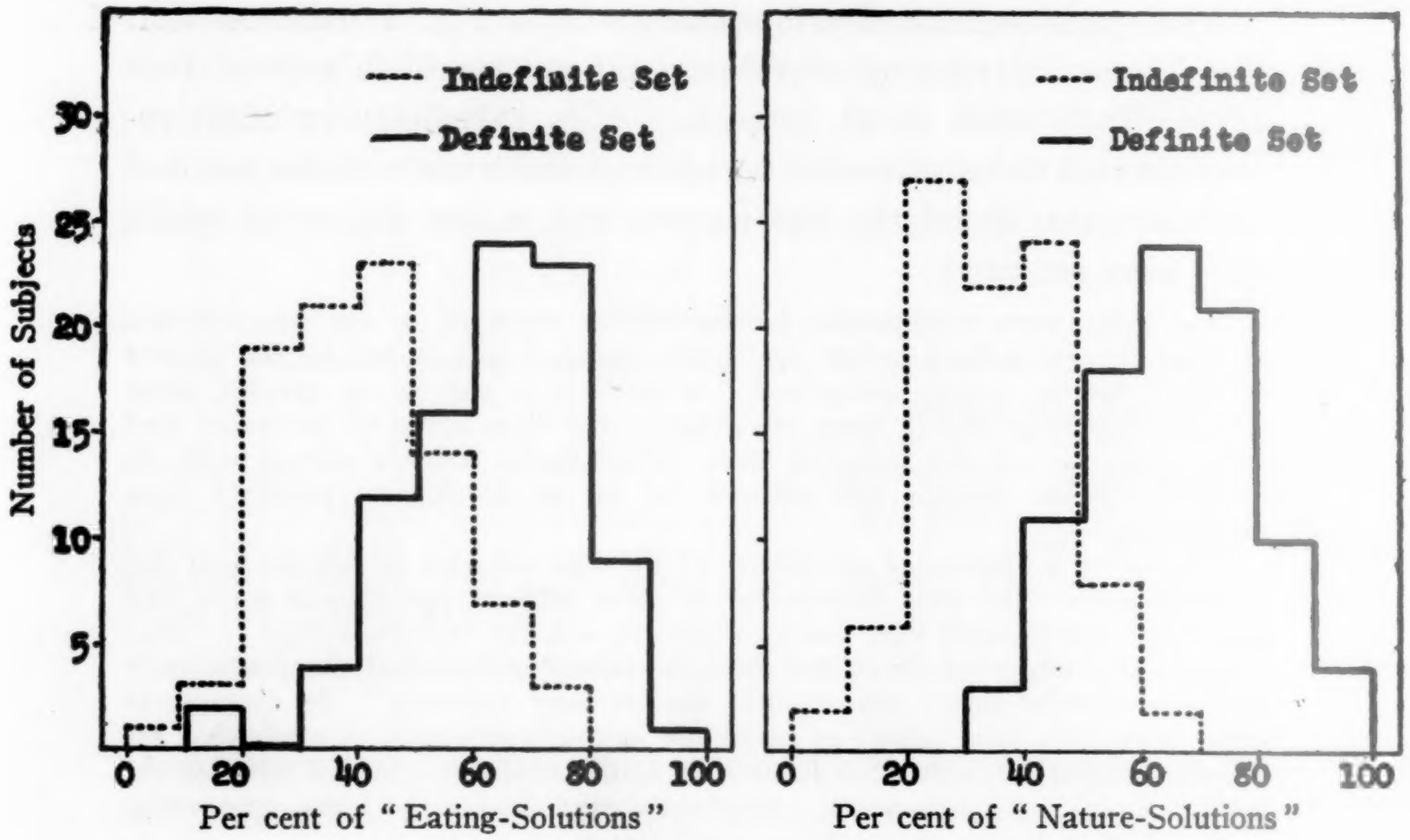


FIGURE 1

Histograms of the Frequency of Percentages of Prescribed Solutions by Subjects with Indefinite Set and by Subjects with Definite Set.

and "eating-solutions" rise from 36 and 30 in the series with no prescribed set (Series AN and AE) to 60 and 63 in the series with congruent sets (Series BN and BE). Naturally, the percentages for Series AN and AE are based on only the ten critical items.

This difference between the averages of the A series and the B series for each group seems to be a valid indication of the influence of the set aroused by the instructions. There seems to be no reason to suspect that the critical anagrams of the two series differed appreciably in difficulty. The anagrams were constructed merely according to the principle of concealing obvious solu-

tions. Although differences of difficulty undoubtedly arise when different arrangements or orders of letters are used, the complex character of any item together with the tremendous individual differences which exist among subjects make any attempt at standardization impractical. In any case, it seems unlikely that we should have assigned to any particular series precisely those items and arrangements which would render the prescribed solutions consistently more difficult or less so for so large a number of subjects.[5]

If we were to ascribe the differences obtained to differences in relative familiarity of the various solutions, we should again have to assume that the arrangement of material happened to be just that to provide consistently the particular selective effect obtained, an assumption which seems hardly plausible.

The spread of the distributions given in Fig. 1 indicates that the definite instructions obviously did not establish sets of uniform effectiveness in all subjects. This variability in effectiveness seemed to be primarily a result of differences in the manner of interpretation of the instructions and in the degree to which they were accepted.

That there were considerable differences, for example, in the interpretation of what the instructions meant by "nature-words" was shown by the reports of the subjects. Some interpreted "nature" in a narrow or specific sense (*e.g.*, as referring only to trees and plants); for these many of the terms used were really beyond the scope of their expectations. Others started with an extremely broad concept and allowed the set to develop as solutions were discovered.

Differences in degree of acceptance of the sets are also clearly brought out in the reports. The main motivation for some subjects was toward speed, and they "felt that it might slow down solution to look for 'nature-words.'" These subjects also remarked that since the instructions implied that there was more than one solution they "did not take the set very seriously." In contrast to these cases there were others in whom the instructions served to establish a set which operated perfectly effortlessly and automatically in that no self-instructions to look for "nature-words" occurred during the series. Here, apparently, a much higher degree of acceptance was present.

Data upon the effects of the sets upon speed of solution were also obtained. A comparison of the time scores for the series with indefinite and definite sets does not yield the striking contrast which might be expected (see Table I). Foster and

[5] It is true that the percentages of "eating-" and "nature-solutions" in Series A might have been expected to be about 50 on the basis of mere chance. The explanation of the low figures obtained seems to lie, however, in the fact that 4 of the 10 "eating-anagrams" and 3 of the 10 "nature-anagrams" offered the possibility of more than two solutions. Since approximately the same proportion of the anagrams in Series B (10 of 20 "eating-anagrams" and 9 of 20 "nature-anagrams") offered more than two possibilities of solution, the obtained difference between the averages of the series could not have been greatly influenced although the absolute percentage may have been reduced throughout.

Tinker's results indicate that when there is a definite set congruent with the one possible solution of a simple anagram, the time for solution is much shorter (10 sec. as compared with 25 sec. for indefinite set). The figures of Table I, on the other hand, show that with ambiguous anagrams the presence of a definite set decreases the time by only 8.4 sec. for the group set for "eating-words" (Series AE and BE) and by only 3.88 sec. for the group set for "nature-words" (Series AN and BN).

This increased speed of solution under conditions of definite set is true of 75 per cent of the subjects and the differences are statistically significant. However, that these differences are to be interpreted as the results of the effects of a definite mental set is highly questionable. Since no attempt was made in the design

TABLE I

SPEED OF SOLUTION WITH DEFINITE AND INDEFINITE SET

	Average* Time Scores	
Series	Indefinite Set	Definite Set
Series AE (Subject I)	19.3 sec.	
Series BE (Subject I)		10.9 sec.
Series AN (Subject II)	14.96	
Series BN (Subject II)		11.08

* The individual median times are averaged to give the group figures.

of the experiment to control practice effects, some proportion of the obtained differences between Series A and B must certainly be attributed to practice effects. Furthermore, since the students acted alternately as *S*, it is extremely likely that each received some indirect practice while acting as *E*.

Computation of the time scores for each half of Series A and B revealed that the increments of increase in speed occurred in a fairly regular manner resembling those of the ordinary practice curve. It is true that a slightly larger difference (4.7 sec.) obtained between the latter half of Series A and the first half of Series B than between the two halves of either series alone (A, 1.56 sec., B, 1.13 sec.). However, indirect practice during the interval would seem to account for this larger difference, since a similarly large difference (4.34 sec.) was found between the medians of the two Series A (see Table I). Here, also, Subject II had acted as *E* before solving her own Series A.

The possibility presents itself that true differences in speed, due to the factor of definite set, might exist for those subjects for whom the set was highly effective. Such differences might fail to have a perceptible effect upon the gross averages of the whole groups. We divided the entire group of subjects

into two groups, on the basis of effectiveness of the set as indicated by the percentage of critical anagrams in Series B solved in congruence with the set. Those who obtained 65 per cent, or more, "eating-" or "nature-solutions" formed the "Effective Set" group. The remainder fell into the "Less Effective Set" group. (See Table II.)

There is virtually no difference between the two groups in the amount of improvement in speed under conditions of definite set. Although the "Effective Set" group is more rapid than the other in Series A, its relative improvement in Series B is identical with that of the other group, the differences between A and B being 6.8 sec. and 6.4 sec. respectively. This negative finding lends further weight to our conclusion that there exists no reliable difference between the time scores of Series A and B which can be attributed to the effect of the definite set. The explanation of the discrepancy between our results and Foster and Tinker's appears to lie in the fact that while Foster and Tinker's anagrams admitted, for the most part, of only one solution, a word congruent with the given set (actually 16 of the 80 were ambiguous although only 4 are so listed), our anagrams offered two or more possible solutions. Few, if any, out-of-set

TABLE II

DEPENDENCE OF SPEED UPON EXTENT TO WHICH SET WAS EFFECTIVE IN DETERMINING CHARACTER OF SOLUTIONS

	Time Score Series A (Indefinite Set)	Time Score Series B (Definite Set)
"Effective Set"......................	16.3 sec.	9.5 sec.
"Less Effective Set"....................	19.8 sec.	13.4 sec.

solutions would be obtained under Foster and Tinker's conditions, since the simple anagrams would constantly reinforce the set. If our critical anagrams were scattered through a long list of simple anagrams of the same type, we should undoubtedly find that increased speed of solution, as well as a larger proportion of solutions in congruence with the set, would result.

EXPERIMENT II

THE EFFECTIVENESS OF SPECIFIC SETS ESTABLISHED WITHOUT THE USE OF INSTRUCTIONS

In the previous experiment, it was found that when sets were imposed upon the subjects by means of instructions given in advance, considerable variability in interpretation resulted. In the present experiment, an attempt was made to build up specific sets wholly through experience with actual materials of appropriate nature. The same specific sets and the same critical series as were used in Experiment I were utilized here. New series of simple anagrams whose solutions were all related in meaning were introduced as training-series for the establishment of specific sets.

The order of procedure for the two groups follows:

Group E

Training-series; items 1–20; simple anagrams; "eating-solution" *only*.
Critical series; items 21–40; ambiguous anagrams; possible "eating-solution" (Series BE of Experiment I).

Group N

Training-series; items 1–20; simple anagrams; "nature-solution" *only*.
Critical series; items 21–40; ambiguous anagrams; possible "nature-solution" (Series BN of Experiment I).

Through the choice of words for the training-series, and their arrangement within the series, we attempted to provide for the establishment of a set as appropriate as possible to the critical series. We were somewhat hampered in our efforts by the small number of suitable five-letter words.

There were 17 subjects in each group.[6] Subjects were taken individually; otherwise the procedure varied in no essential way from that of Experiment I. The subjects were instructed merely to solve the anagrams and in this case no hint was given as to the possibility of more than one solution.

Lists composed of the 20 critical anagrams (21–40 above) scattered among 20 unrelated items constituted the material for two control groups of 10 subjects each.

The high percentages of critical anagrams solved in accordance with the given set demonstrate conclusively that by the training-method it is possible to establish specific sets equally as effective as those established by verbal instructions. (See Fig. 2.)

The average for the group with the "nature-set" established through training (Group N) is 66.5 per cent; that for the comparable group given verbal instructions (Group BN of Experiment I) is 63 per cent. Figures for the groups with "eating-sets" are 50.9 per cent for the group with training (Group E) and 60 per cent for the instructed group (Group BE of Experiment I). Although the difference in the latter case represents really a difference of only two solutions, it is still probably significant because of the narrow range of the scores for Group E. The lower effectiveness of the "eating-set" when established by this method seems to be a result of the fact the particular training-series used proved to be one which induced too specific a set. Choice of words for the "nature-series" seemed more fortunate, reports of subjects indicating that the set established was highly appropriate to the words of the critical series.

The results of this experiment shed some light upon the problem of the relation between the degree of acceptance of the set and the number of critical anagrams solved in congruence with it. Solely on the basis of introspective reports, the subjects of

[6] That the size of these groups was ample to give fairly reliable data is shown by the uniformity of the results of the seven laboratory sections in Experiment I. In some sections, there were as few as 10 subjects in each group, yet the averages of these groups varied little from the general average.

Experiment II can be divided into two groups which we have called the Accepting and the Suspecting Groups. The latter group is composed of those subjects who never regarded the relationship between the items as dependable but rather kept " expecting a catch " in the experiment, a change in the relationship or its cessation. The Accepting Group, on the other hand, simply took the relationship at face value as an inherent part of the situation,

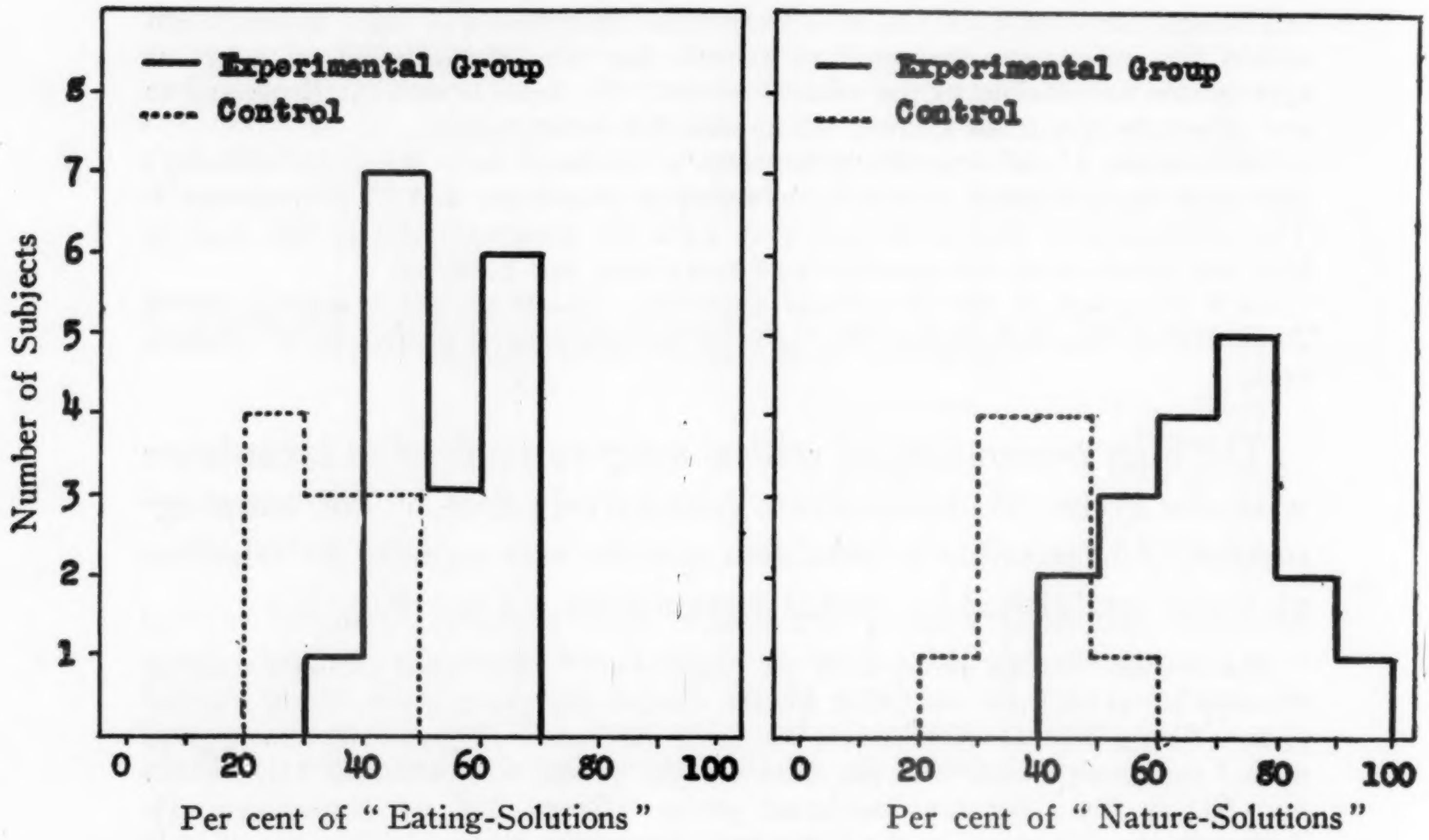


FIGURE 2

Histograms of the Frequency of Percentages of Prescribed Solutions by Subjects with Congruent Set (Established Without Instructions) Compared to Those of Subjects of Control Groups.

regarding out-of-set solutions as mere exceptions. While errors in the classification of subjects may have occurred, the percentages of critical words solved by the Accepting and Suspecting Groups show that rather marked differences existed (See Fig. 3). In terms of averages, the Suspecting Group solved only 42.9 per cent of the anagrams in congruence with the " eating-set," while the Accepting-Group solved 56.6 per cent. The averages for the " nature-set " are 49.2 per cent and 74.0 per cent for the Suspecting and Accepting groups respectively.

A further difference in the manner in which the sets operated for various subjects is indicated by the subjects' reports, a difference in the degree to which the sets involved a conscious attitude of search for related words. Of the 34 subjects, only 11 reported awareness of such an attitude accompanying realization of the relatedness of the words. For the others, the reports indicated that the sets had operated automatically. There seems to be no

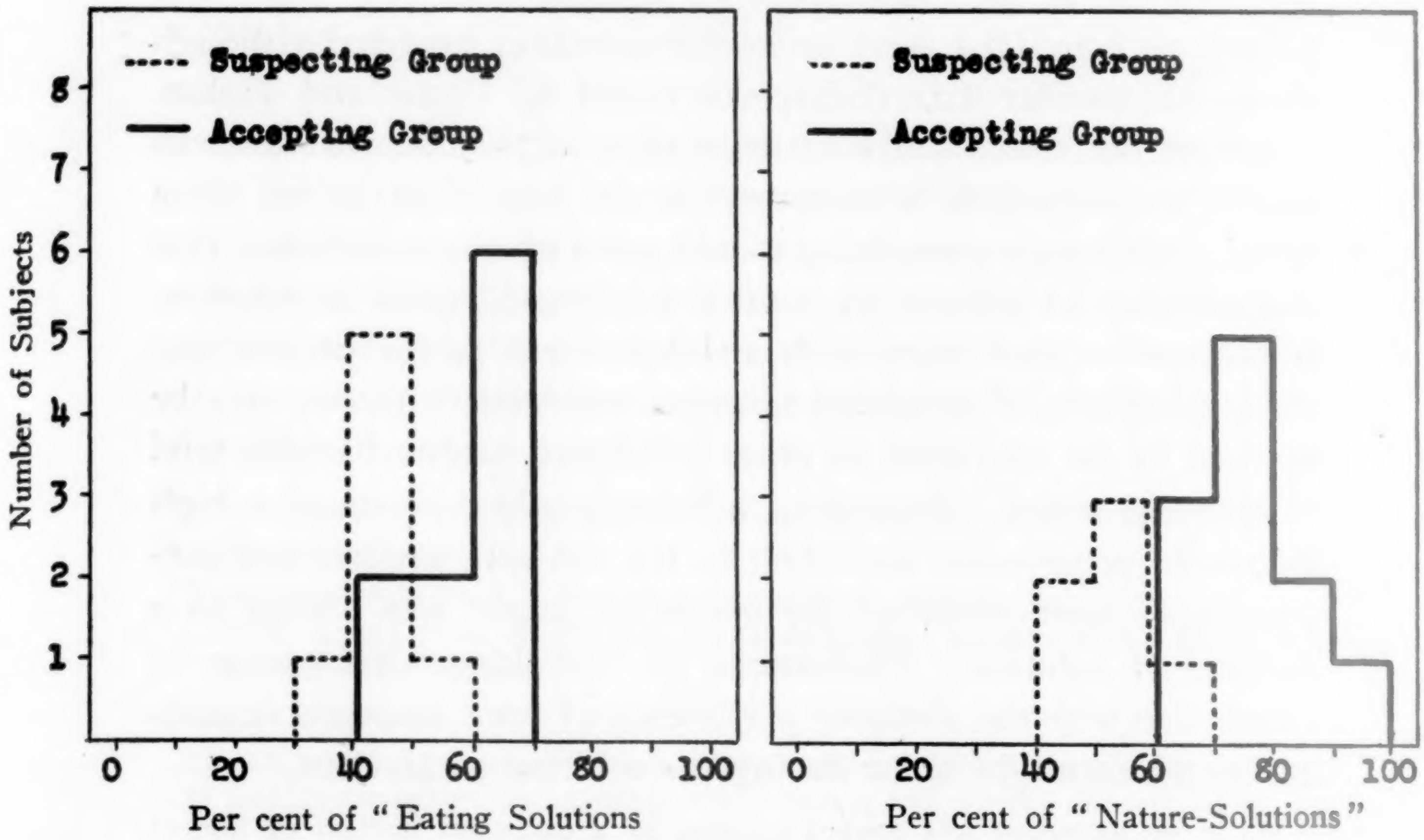


FIGURE 3

Histograms of the Frequency of Percentages of Prescribed Solutions as Related to Low and High Degrees of Acceptance of the Sets.

relation, so far as we can discover, between the presence of a conscious attitude of search and either the degree of acceptance of the set or its effectiveness in determining nature of solution. Conscious directedness appears, therefore, to be by no means a necessary or significant determinant of the effective operation of sets.

With respect to speed in solution, the time scores for Experiment II tend to support the hypothesis suggested before to the effect that appreciable increase in speed with specific set occurs only when there is constant reinforcement of the set through the

use of simple anagrams, all related to the set (as by Foster and Tinker). Time scores for our training-lists of simple anagrams all solved in congruence with the set are lower than those for control lists of ambiguous anagrams unrelated to any common set. The most comparable results available from our experiment are the following. The average time for the second half of the training-series (anagrams 11–20) was 10.5 sec. and that for control subjects at the same stage of practice was 16.8 sec. The difference here (6.3 sec.) is in the direction expected although somewhat smaller than differences found by Foster and Tinker.

Altogether, mere statistical treatment of time scores seems to reveal relatively little with respect to the real effects of set upon speed. Although everything would point to the conclusion that the influence of definite set is toward increased speed of solution, it becomes evident from such an experiment as the present one that the effects, if measured in gross quantitative terms, may be masked by the operation of other influences, some of which tend to decrease speed. Secondary influences which assumed a high degree of prominence according to the subjects' reports and performances were often of the nature of minor sets related to a method of solution. Phenomena of "blocking" also arose in connection with the obstinate persistence of some incorrect organization which might occur during the solution of an item.

Minor or secondary sets toward solution by a particular method or line of attack apparently arose in practically all subjects. A most common type was a set toward organizing solutions around some combination of consonants. Certain of these letter-combinations (*e.g.*, *fr*, *ch*, *st*) constituted for the subject such obvious and coherent points of orientation about which to build a word that it often became very difficult to discard them. The illustrations seem typical of the kind of method-sets which play an extremely important rôle in the process of solution. No subject was found who adopted a method of trying systematically all possible letter-orders; invariably the method was that of introducing variations in trial organizations which looked promising. Another type of minor set arose almost invariably in connection with the presence of a letter *s* which might be used as the final letter to form a plural. The subject often was unable to see the possibility of using this letter in any other rôle. It is obvious that minor sets of both of the types described may exert an important influence upon both the speed and the nature of the solutions.

Discovery of a correct solution was often retarded or blocked by the occurrence of certain kinds of false solutions. Particularly persistent in such effects were initial solutions which were real words but did not employ the letters given or were not of proper length and solutions which fitted the materials but were not real English words (foreign words, proper names, coined words).

The nature and arrangement of a particular anagram might often be a factor in suggesting such a false solution. Once an agreeable organization has been tried, it seems to produce a striking inflexibility on the part of the subject which often overshadows possible influences of the specific major set.

Experiment III

The Establishment of Sets for Solutions by Verbs Rather than by Nouns

We have found that sets of the type with which we are dealing can be established by the training-method as effectively as by instructions. The training-method holds promise of providing more adequate control of sets because of its dependence upon concrete materials which may be conveniently manipulated. This experiment and those which follow were designed primarily to explore some of the possibilities of this method. The attempt was first made to establish a specific set for solutions in the form of verbs rather than nouns.

The experiment was performed according to the following plan:

Experimental Group

Training-series; items 1–15; simple anagrams; verb-solution *only*.

Critical series; items 16–30; ambiguous anagrams; possible verb-solution and possible noun-solution.

Control Group

15 simple anagrams; 8 with verb-solution only; 7 with noun-solution only.

15 ambiguous anagrams; possible verb-solution and possible noun-solution.

For the Control Group, the 15 critical items were scattered among the 15 simple anagrams. There were 5 subjects in each group. The experimental procedure was identical with that of Experiment II.

The percentage of verb-solutions in the critical series was practically the same for the Experimental Group as for the Control Group. The average for the Experimental Group is 45 per cent while that for the Control Group is 41.3 per cent. Scores for individuals are highly consistent with these average figures so that the small number of subjects does not seem to be responsible for the lack of significant difference. It seems clear that the attempt to establish this particular set failed in so far as can be told from effects upon the nature of the solutions. The most plausible explanation, in the light of the subjects' reports, is that for the task of solving anagrams the distinction between verbs

and nouns is an extremely meaningless one completely foreign to the intrinsic nature of the task.

This explanation is supported by the fact that no one of the subjects noticed that the first 15 solutions of the training-series were all verbs. In fact, when questioned at the end of the series the subjects could not answer as to the parts of speech involved. In the anagram-situation, the division of meanings into the categories of verbs and nouns seems not to occur.

Our interpretation is also supported by results of a supplementary experiment performed upon 5 subjects who were given the same material with the added instructions to look for verbs. The average percentage of critical anagrams solved as verbs by these subjects was 58.6 per cent, a figure higher than that for the training-method alone (45 per cent) but still indicating a rather low degree of effectiveness when compared with the figure (66.5 per cent) for a "nature-set" established by the training-method alone. The subjects of the instructed group complained of the difficulty of maintaining the set for verbs and of the necessity for conscious effort.

Experiment IV

The Establishment of a Set Favoring Solutions Employing a Certain Order in the Rearrangement of Letters

This experiment was suggested by the readiness with which subjects developed various sets related to the method of solution. The attempt was made to establish a set for obtaining the solutions by transposing letters according to a plan dependent wholly upon the order of arrangement. In terms of numbers indicating their positions in the solution-word, the letters appeared always in the anagram in the order 54123 (*e.g.*, "camel" was presented as "lecam").

The plan of the experiment was as follows:

Experimental Group
- Training-series; items 1–15; simple anagrams; 54123 order.
- Critical series; items 16–30; ambiguous anagrams; one solution in 54123 order; other solutions possible.

Control Group
- 15 simple anagrams; haphazard order.
- 15 ambiguous anagrams; one solution 54123 order; other solutions possible.

For the Control Group, the critical items were scattered among the simple anagrams. There were 10 subjects in each group. The procedure remained the same, except for the fact that the response-words were recorded by the experimenter rather than by the subject.

It is obvious from the results (see Fig. 4) that the particular set for a certain letter-order was highly effective. In terms of averages, the Experimental Group solved 94.6 per cent of the critical anagrams according to the prescribed order whereas the percentage for the Control Group was 47.3.

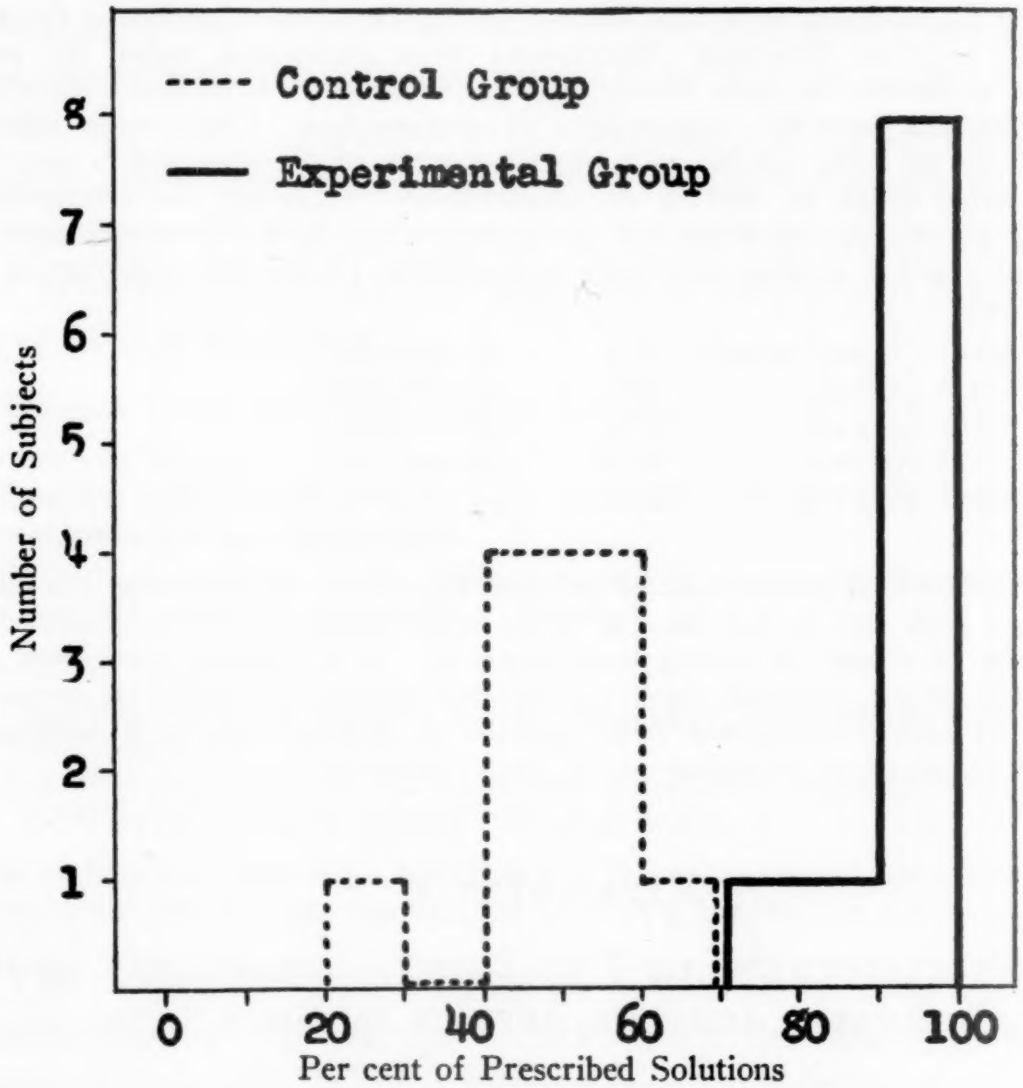


FIGURE 4
Histograms of the Frequency of Percentages of Prescribed Solutions by Subjects with a Set for a Certain Letter-Order Compared to Those of Subjects of a Control Group.

The most significant feature of this experiment was its demonstration that the set could operate at such a high level of effectiveness without the subject's being aware of its existence. We have, then, the set producing its results on the solutions while to the subject each anagram seems to present a separate, real problem which he approaches and solves without any notion that he is following a certain procedure.

All of the 10 subjects observed that the solutions became very easy as they progressed through the series. To 6 subjects there occurred no idea that the anagrams involved any regular order of arrangement. The other 4 subjects, all of whom were teachers or advanced students of psychology, gained a general notion that the anagrams were all made in the same way. Only 1 subject detected the actual system of arrangement. The percentages of prescribed solutions were 100 for the 4 subjects who gained some insight into the arrangement and 91.3 for those who remained completely unaware of any plan or set. The latter figure indicates a remarkably high degree of effectiveness of the set.[7]

Several informal additional experiments were performed, using the same technique as before but with fewer subjects, in order to investigate the effectiveness of sets favoring other orders of arrangement. The results indicate that it would be quite possible to construct a series of different orders covering a fairly wide range of degrees of effectiveness. Including the arrangement described above the following list of arrangements with the percentages of prescribed solution yielded represents a beginning toward the construction of such a series.

order 52143	(*lacem*, camel)	47%	(3 subjects)
order 51432	(*lcema*)	52%	(3 subjects)
order 32145	(*macel*)	62%	(10 subjects)
order 54123	(*lecam*)	95%	(10 subjects)
order 23145	(*amcel*)	100%	(5 subjects; in this case the subjects became aware of the arrangement)

A principle which seems to be of primary importance in governing the effectiveness of such sets is that the degree of effectiveness is inversely related to the amount of change in arrangement required. It is obvious even from our results that such a principle cannot be applied merely in mechanical terms of numbers of letters transposed from position to position but must eventually involve a treatment of arrangements as total structures.

Experiment V

The Establishment of Two Sets in Congruence or in Opposition and the Effects of Such Combinations upon the Solutions

The proof that an effective set may be established without the subject's knowledge and may operate automatically or unconsciously suggests direct investigation of the combined effects when such a set is built up along with a set operating consciously. Establishment of one of the sets at an automatic level has the advantage of excluding rational or interpretative combination of the sets in advance, as would occur if instructions of

[7] Gottschaldt (4) has done extensive experimentation in the field of perception using a similar technique to establish unconscious attitudes. Here also temporal order was the factor producing the set. These attitudes were shown to have high effectiveness in determining perceptual organization.

two different kinds were given or if the two sets were recognized consciously.

The present experiment represents an attempt to determine the effects of such combinations when the relationship between the two sets is that of congruence or that of opposition. The sets used were the " nature-set " of Experiment II, known to operate consciously and to produce about 67 per cent prescribed solutions in conjunction with a given critical series and an automatic letter-order set (32145) found in Experiment IV to be of approximately equal effectiveness (62 per cent) when operating singly. The relationship of congruence or opposition was controlled by the provision of suitable possibilities of solution in the arrangement of the anagrams.

The plan of the experiments was as follows:

Congruence Group
- Training-series; items 1–20; simple anagrams; 32145 order; "nature-solution" only.
- Critical series; items 21–40; ambiguous anagrams; possible "nature-solution" in 32145 order; other solutions possible.

Opposition Group
- Training-series; items 1–20; simple anagrams; 32145 order; "nature-solution" only.
- Critical series; items 21–40; ambiguous anagrams; "non-nature-solution" in 32145 order; "nature-solution" in other orders.

In each group there were 10 subjects. The experimental procedure was the same as that for previous experiments employing the training-method.

The results for the Congruence Group show clearly that this combination of the " nature- " and letter-order sets, each approximately 65 per cent effective alone, served to increase markedly the number of prescribed solutions. With the two sets combined, an average of 85 per cent of the critical anagrams were solved as " nature-words."

For the Opposition Group, the results indicate that when the material requires solution in accordance with either one set or the other, the letter-order set is likely to prevail in determining the direction of solution. With respect to the percentage of "nature-solutions," the average for the Opposition Group (35 per cent) is practically identical with that for the Control Group (37 per cent) of Experiment II. Obviously, the presence of the "nature-

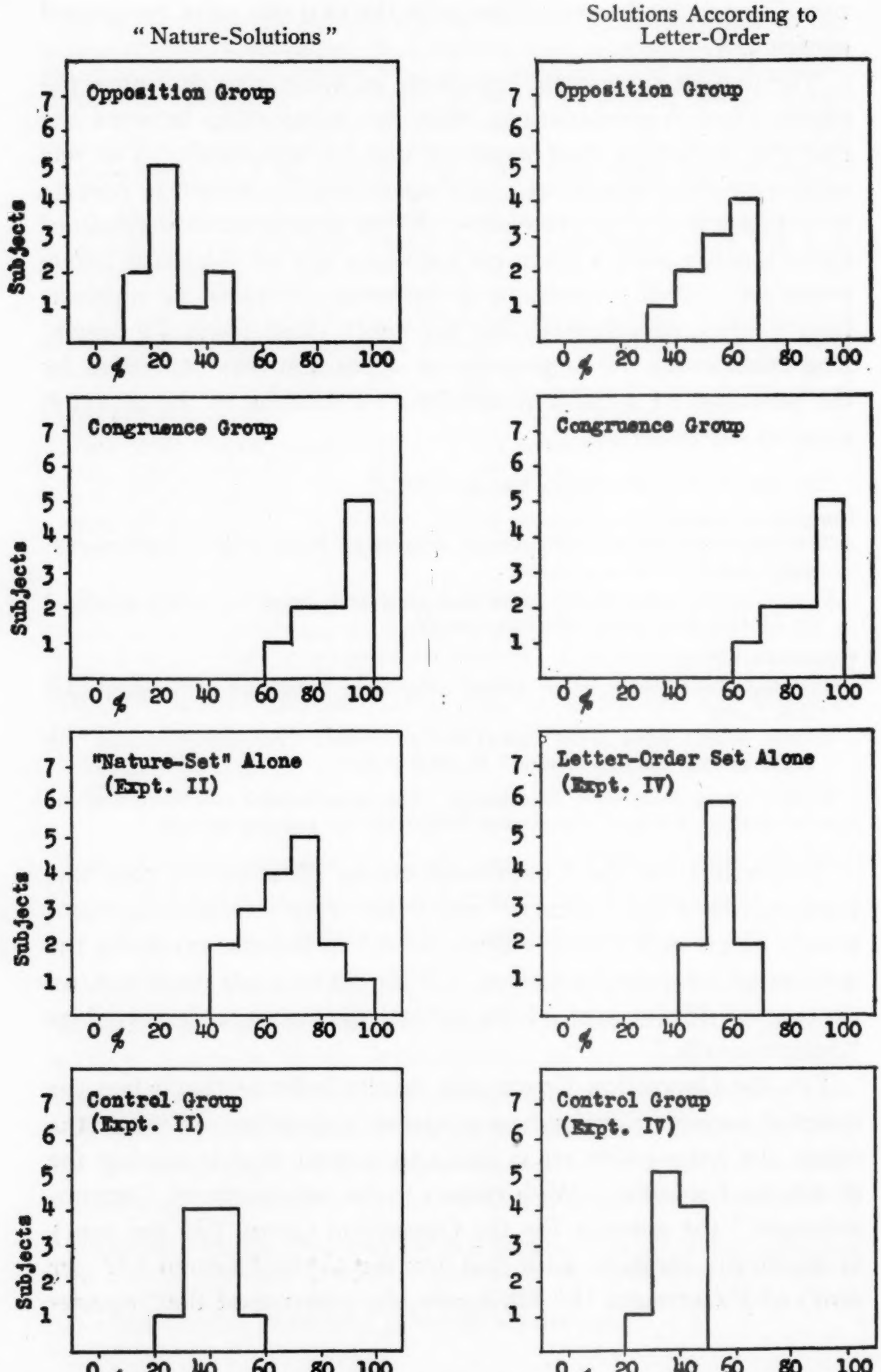


FIGURE 5

Effects of Combining Two Sets Compared with Effects of Each Set Operating Singly and with Results for Control Groups.

set" did not influence the solutions to any marked extent. With respect to the percentage of letter-order solutions, on the other hand, the average of the Opposition Group (52.5 per cent) is much greater than that for the Control Group of Experiment IV (36 per cent) and approaches that for the group in which the order-set operated alone (62 per cent).

Comparison with respect to "nature-solutions" in the Opposition and Congruence Groups yields the most striking contrast. Here, not only was there a large difference between the percentages of "nature-solutions" (Opposition Group, 35 per cent; Congruence Group, 85 per cent) but there was no overlapping of the distributions of individual scores. With respect to solutions in accordance with the letter-order set, the difference was naturally

TABLE III

Group Averages of Individual Median Time Scores Under Different Conditions of Set

	Time Score for Training-Series	Time Score for Critical Series
"Nature" alone	10.4 sec.	11.0 sec.
Letter-order alone	4.4	3.7
Congruence	1.25	2.9
Opposition	1.4	8.3

smaller, since this set was dominant for the Opposition Group (the averages are 62 per cent for the Opposition Group and 85 per cent for the Congruence Group).

That there was some real process of combination or interaction between the two sets is indicated by the results on speed of solution. When the two sets were congruent, the time scores in the critical series remained relatively short, although there was some increase over those of the training-series. When the two sets were in opposition, however, there was a tremendous increase in the time scores for the critical series such as was found under none of the other conditions (see Table III). It is clear that the presence of the "nature-set" tended in the latter case to hinder the operation of the letter-order set.

The manner in which the set for a certain letter-order is shown to be dominant over one for "nature-words" is the most striking feature of the results of Experiment V. The facts seem to sug-

gest an interpretation in terms of the intrinsic relations of the different sets to the situation and task. (Such an interpretation has already been suggested previously in connection with the set for solutions as verbs rather than as nouns). In the solution of anagrams, the process of search meets constantly with the limiting and directing influence of the formal requirements of the task. Whatever other influences may be operating, there is always the primary necessity for dealing in terms of certain possibilities in rearrangement of the letters. Sets related to the order of letters enforce their influence along the lines of this primary and essential feature of the task. On the other hand, sets defined in terms of the meaning-character of the solution-words introduce an additional requirement which is not directly related to the basic operations of anagram-solution.

Summary

Experiments included in the present study concern primarily the effects of various types of mental set upon the character of solutions obtained for anagrams. The technique involved the use of especially constructed, "ambiguous," anagrams offering possibilities of solution in more than one way.

Sets established by the usual method of verbal instruction were shown to influence definitely and consistently which one of alternative solutions would be obtained. Although the presence of a specific set had, in general, the effect of increasing speed of solution, it was seen that this effect might easily be absent because of the operation of other factors influencing speed.

It was found possible to build up through experience or training with materials of appropriate nature sets equally as effective as those established by instructions. It was also found that a set may operate to a high degree of effectiveness without the subject's being aware of the set or of any common feature in the materials or solutions.

Different sets are not all equally effective. One principle which seems to be of primary importance here is that sets which are related to the intrinsic nature of the task are most effective. The high effectiveness of sets defined in terms of letter-order as con-

trasted with the lower effectiveness of sets related to the meaning-character of solutions illustrates this principle.

Effects of the establishment of two different sets in connection with a single task were also investigated. A conscious set to look for solutions with certain meaning-character and an automatic or unconscious set favoring the use of a certain letter-order in solution were used in combination. When the material was so arranged that the same solution would be arrived at through the operation of either set, the effect was one of facilitation of the prescribed solutions. When the material was arranged to allow separate solutions according to either set, the letter-order set was clearly dominant in accordance with expectations based upon the principle suggested above.

References

1. Ach, N. *Über den Willensakt und Temperament.* Leipzig: Quelle u. Meyer, 1910. Pp. 324.
2. Duncker, K. A qualitative study of productive thinking. *Ped. Sem.*, 1926, **33**, 642–708.
3. Foster, W. S., and Tinker, M. A. *Experiments in psychology* (including Notes for instructors). New York: Holt, 1929. Pp. 392.
4. Gottschaldt, K. Über den Einfluss der Erfahrung auf die Wahrnehmung von Figuren. II. *Psych. Forsch.*, 1929, **12**, 1–87.
5. Heidbreder, E. F. An experimental study of thinking. *Arch. Psychol.*, 1924, **11**. Pp. 175.
6. Kline, L. W., and Kline, F. L. *Psychology by experiment.* Boston: Ginn, 1927. Pp. 339.
7. Langfeld, H. S., and Allport, F. H. *An elementary laboratory course in Psychology.* Boston: Houghton Mifflin, 1916. Pp. 147.
8. Lewin, K. Das Problem der Willensmessung und das Grundgesetz der Assoziation. I. *Psych. Forsch.*, 1922, **1**, 191–302; II. *Ibid.*, **2**, 440–447.
9. Maier, N. R. F. Reasoning in humans. I. *J. Comp. Psychol.*, 1930, 10, 115–143; II. *Ibid.*, 1931, 12, 181–194.
10. Starch, D. *Experiments in educational psychology.* New York: Macmillan, 1911. Pp. 183.

Lists of Anagrams Used in the Various Experiments

Practice List Given to Subjects Prior to All Experiments

Anagram	Solution
saree	erase
ihrac	chair
rdesi	rides dries
cikbr	brick
uheso	house
stniw	twins
greti	tiger
ehlaw	whale
ulenc	uncle
eprpa	paper

Experiment I

(Sets Produced by Verbal Instructions)

Series AE Indefinite Set "Eating"

Anagram	Solution
ahesr	hares share hears shear
ilmse	miles slime limes smile
rcamh	charm march
rtbho	throb broth
prele	repel leper
aceus	cause sauce
lpeso	slope poles lopes
nesiw	swine sinew wines
hignt	night thing
avdni	divan viand
aceth	teach cheat
ottur	tutor trout
sheta	haste hates heats
atrts	start tarts
ltsae	slate tales steal stale least
attse	state taste teats
ortew	wrote tower
piesc	epics spice
eswvi	wives views
asmle	males meals lames

Series BE Definite Set "Eating"

Anagram	Solution
aephc	peach cheap
mlsup	plums lumps slump
epsra	pears pares rapes spare parse spear reaps
tdesa	dates sated stead
iovle	olive voile
drabe	bread bared beard debar
aesmt	meats steam teams tames mates
eskat	steak takes stake skate
vrace	carve crave
ridfe	fried fired
malcs	clams calms
aseft	feast feats fates
rsvee	serve verse sever veers
rasyt	trays stray satyr
wbosl	bowls blows
altpe	plate pleat leapt petal
haicn	china chain
ponso	spoon snoop
labet	table bleat
tevso	stove votes

Series AN Indefinite Set "Nature"

Anagram	Solution
lipsl	pills spill
rtesa	stare tears aster rates tares
rheso	horse shore
serpi	spire piers pries
rahet	heart earth hater
angor	organ groan orang
gired	dirge ridge
mspac	camps scamp
mplas	lamps palms plasm psalm
ilans	nails snail slain
elest	steel sleet
esfhl	flesh shelf
nispe	spine pines penis snipe
itans	saint stain satin
udlco	could cloud
atwsr	straw warts swart
srtof	forts frost
rwecs	crews screw
adels	leads deals dales
odsrw	words sword

Series BN Definite Set "Nature"

Anagram	Solution
eosrs	roses sores
lepta	petal pleat leapt plate
rnhto	thorn north
ltska	stalk talks
ortos	roots torso roost
etsre	trees steer terse reset
dacre	cedar raced cared
ewdes	weeds sewed
dflei	field filed
smahr	marsh harms
opsol	pools spool loops sloop
kelas	lakes slake leaks
aceno	ocean canoe
esitd	tides diets edits deist
acsot	coast coats
esref	reefs frees
otnse	stone tones notes onset
srokc	rocks corks
aekps	peaks speak spake
nerag	range anger

Experiment II

(Sets Produced by Training-Series)

Training-Series for Experimental Group E "Eating"

Anagram	Solution
dnyca	candy
aeksc	cakes
gsrau	sugar
acmer	cream
ococa	cocoa

Training-Series for Experimental Group N "Nature"

Anagram	Solution
donsp	ponds
rokbo	brook
vreri	river
ekcer	creek
mawps	swamp

EXPERIMENT II (CONTINUED)
(*Sets Produced by Training-Series*)

Training-Series for Experimental Group E
"Eating"

Anagram	Solution
idnkr	drink
oabnc	bacon
nooni	onion
etebs	beets
snabe	beans
vesno	ovens
clnuh	lunch
fiken	knife
kosfr	forks
ladsa	salad
reybr	berry
upenr	prune
perag	grape
iftur	fruit
plepa	apple

Training-Series for Experimental Group N
"Nature"

Anagram	Solution
trewa	water
nirsa	rains
nsswo	snows
otsmr	storm
iwdsn	winds
naptl	plant
sargs	grass
esnfr	ferns
aillc	lilac
metss	stems
ypppo	poppy
edses	seeds
lutpi	tulip
ubbsl	bulbs
aspyn	pansy

Critical Series for Experimental Group E
"Eating"
(Same as Series BE of Experiment I)

Critical Series for Experimental Group N
"Nature"
(Same as Series BN of Experiment I)

Series for Control Group for Group E
"Eating"

Anagram	Solution
ahesr	hares hears share shear
*aepch	peach cheap
rcamh	march charm
mlsup	plums lumps slump
prele	leper repel
epsra	pears pares spare spear rapes reaps parse
lpeso	slope lopes poles
tdesa	dates sated stead
hignt	thing night
iovle	olive voile
aceth	teach cheat
drabe	bread beard bared debar
sheta	hates heats haste
eskat	steak takes stake skate
ortew	wrote tower
aesmt	meats teams mates steam tames
*ltsae	stale tales steal slate least
*vrace	crave carve
eswvi	wives views
ridfe	fried fired
lipsl	pills spill
*malcs	clams calms
serpi	piers spire pries
*aseft	feast feats fates
angor	organ groan orang
rsvee	serve verse sever veers
mspac	camps scamp
rasyt	trays satyr stray
ilans	slain nails snail
wbosl	bowls blows
*esfhl	flesh shelf
*altpe	plate petal leapt pleat
itans	satin saint stain
*haicn	china chain
*atwsr	warts straw
*ponso	spoon snoop
rwecs	crews screw
*labet	table bleat
odsrw	words sword
*tevso	stove votes

Series for Control Group for Group N
"Nature"

Anagram	Solution
ahesr	hares hears share shear
eosrs	roses sores
rcamh	march charm
lepta	petal pleat plate leapt
prele	leper repel
rnhto	thorn north
lpeso	poles slope lopes
ltska	stalk talks
hignt	thing night
ortos	roots roost torso
aceth	teach cheat
etsre	trees steer
sheta	hates heats haste
dacre	cedar cared raced
ltsae	stale tales least slate steal
ewdes	weeds sewed
ortew	wrote tower
dflei	field filed
eswvi	wives views
smahr	marsh harms
lipsl	pills spill
opsol	pools loops sloop spool
serpi	piers spire pries
kelas	lakes leaks slake
angor	groan organ orang
aceno	ocean canoe
mspac	camps scamp
esitd	tides diets edits deist
ilans	slain snail nails
acsot	coats coast
esfhl	flesh shelf
esref	reefs frees
itans	satin saint stain
srokc	rocks corks
rwecs	crews screw
otnse	stone tones notes onset
odsrw	words sword
aekps	peaks speak spake
atwsr	straw warts
nerag	range anger

EXPERIMENT III
(*Set Produced by a Training-Series*)

Training-Series for Experimental Group
Verbs vs Nouns

Anagram	Solution
dlebe	bleed
hntik	think
ngrbi	bring

Series for Control Group
Verbs vs Nouns

Anagram	Solution
elamc	camel
uhmto	mouth
dlebe	bleed

EXPERIMENT III (CONTINUED)
(Set Produced by a Training-Series)

Training-Series for Experimental Group
Verbs vs Nouns

Anagram	Solution
ranle	learn
lwlde	dwell
mesoc	comes
yptde	typed
onyej	enjoy
wonrd	drown
dewni	widen
verop	prove
sceae	cease
ownsk	knows
enkwa	waken
tirew	write

Critical Series for Experimental Group
Verbs vs Nouns

Anagram	Solution
pleer	repel leper
admle	lamed medal
iplsl	spill pills
atwis	waits waist
otwhr	throw worth
ewotr	wrote tower
aelsk	leaks slake lakes
ohrbt	throb broth
lcsma	calms clams
rsatt	start tarts
lsalh	shall halls
liksl	kills skill
sebta	baste beast tabes
pesco	copes scope
kesap	speak spake peaks

Series for Control Group
Verbs vs Nouns

Anagram	Solution
ennil	linen
pleer	leper repel
admle	lamed medal
sekds	desks
iplsl	spill pills
hntik	think
atwis	waits waist
ohrbt	throb broth
lodsl	dolls
ewotr	wrote tower
liksl	kills skill
ngrbi	bring
elahw	whale
aelsk	leaks slake lakes
lcsma	calms clams
yptde	typed
rsatt	start tarts
lwlde	dwell
lsalh	shall halls
onyej	enjoy
otwhr	throw worth
arypt	party
sebta	baste beast tabes
ranle	learn
pesco	copes scope
mesoc	comes
kesap	speak spake peaks

EXPERIMENT IV
(Sets for Certain Letter-Orders Produced by Training-Series)

Training-Series for Experimental Group
Letter-Order 54123

Anagram	Solution
nelin	linen
nedoz	dozen
ensce	scene
sdlen	lends
lecam	camel
slfal	falls
dlchi	child
neque	queen
frsca	scarf
peshe	sheep
nitra	train
macre	cream
elwha	whale
ytpar	party
htmou	mouth

Critical Series for Experimental Group
Letter-Order 54123

Anagram	Solution
raspe	spear pears rapes pares spare reaps parse
klsta	stalk talks
nolem	lemon melon
dlsco	scold colds
hsfle	flesh shelf
naorg	organ groan orang
evoli	olive voile

Series for Control Group
Letter-Order 54123

Anagram	Solution
nieln	linen
nozed	dozen
lfsla	falls
raspe	spear pears pares rapes spare reaps parse
klsta	stalk talks
nedls	lends
dlcih	child
nolem	lemon melon
dlsco	scold colds
nquee	queen
hsfle	flesh shelf
afscr	scarf
phsee	sheep
naorg	organ groan orang
evoli	olive voile
ritna	train
egsta	stage gates
camre	cream
poslo	sloop pools loops spool
hawel	whale
tnsai	saint satin stain
tesle	sleet steel
umhto	mouth
naoce	ocean canoe
egran	range anger
cnees	scene
maste	steam meats mates teams tames
macle	camel

Experiment IV (Continued)

(Sets for Certain Letter-Orders Produced by Training-Series)

Critical Series for Experimental Group
Letter-Order 54123

Anagram	Solution
egsta	stage gates
tnsai	saint stain satin
poslo	sloop pools loops spool
naoce	ocean canoe
tesle	sleet steel
maste	steam mates meats teams tames
egran	range anger
eltab	table bleat

Series for Control Group
Letter-Order 54123

Anagram	Solution
tarpy	party
eltab	table bleat

Training-Series for Experimental Group
Letter-Order 32145

Anagram	Solution
euqen	queen
macel	camel
ihcld	child
ihsps	ships
olcck	clock
netts	tents
ergen	green
erfsh	fresh
tamch	match
wotel	towel
sedks	desks
argss	grass
lejly	jelly
nahds	hands
gicar	cigar
racds	cards
oobks	books
ehsep	sheep
iadsy	daisy
labls	balls

Critical Series for Experimantal Group
Letter-Order 32145

Anagram	Solution
uacse	cause sauce
elset	sleet steel
ortut	trout tutor
elfsh	flesh shelf
aelst	least steal stale tales slate
ramch	march charm
ginht	night thing
tasin	satin stain saint
kaber	baker break brake
rohse	horse shore
raeth	earth heart hater
aobrd	board broad
orbth	broth throb
rhsub	shrub brush
aetch	teach cheat
artce	trace crate
orfst	frost forts
ilsme	slime miles smile
tages	gates stage
owsrd	sword words

Series for Control Group
Letter-Order 32145

Anagram	Solution
enequ	queen
uacse	cause sauce
lamce	camel
elset	sleet steel
dlich	child
ortut	trout tutor
pishs	ships
elfsh	flesh shelf
kclco	clock
aelst	least steal tales stale slate
setnt	tents
ramch	march charm
nereg	green
ginht	night thing
sfhre	fresh
tasin	satin saint stain
ctham	match
rohse	horse shore
leowt	towel
raeth	earth heart hater
ekdss	desks
aobrd	board broad
sagrs	grass
rhsub	shrub brush
yjlel	jelly
kaber	baker break brake
shdna	hands
orbth	broth throb
raigc	cigar
aetch	teach cheat
acrsd	cards
artce	trace crate
skobo	books
orfst	frost forts
phese	sheep
ilsme	slime smile miles limes
sdyia	daisy
tages	gates stage
lbsla	balls
owsrd	sword words

(The anagrams in the lists for the other letter-orders of Experiment IV were constructed from the same words as those employed in these lists)

Experiment V

("Nature" Set and Letter-Order Set 32145 Operating in Congruence and Operating in Opposition)

Training-Series for Both Congruence and Opposition Groups
("Nature" Set and Letter-Order Set 32145 in Combination)

Anagram	Solution
nopds	ponds
virer	river
orbok	brook
ercek	creek
awsmp	swamp
tawer	water
iarns	rains
onsws	snows
otsrm	storm
niwds	winds
alpnt	plant
argss	grass
refns	ferns
etsms	stems
iwtgs	twigs
eesds	seeds
iadsy	daisy
lutip	tulip
lubbs	bulbs
napsy	pansy

Critical Series for Congruence Group ("Nature" Set and Letter-Order Set 32145 Operating to Produce the Same Solution)

Anagram	Solution
tsaer	aster stare rates tears
tepal	petal plate pleat leapt
ohtrn	thorn north
atslk	stalk talks
oorts	roots roost torso
ertes	trees steer terse
nipes	pines snipe penis spine
eewds	weeds sewed
eifld	field filed
ramsh	marsh harms
oopls	pools loops sloop spool
kales	lakes leaks slake
ecoan	ocean canoe
dites	tides diets deist edits
aocst	coast coats
ohsre	shore horse
eerfs	reefs frees
aepks	peaks speak spake
lades	dales leads deals
narge	range anger

Critical Series for Opposition Group ("Nature" Set and Letter-Order Set 32145 Operating to Produce Different Solutions)

Anagram	Solution
atsre	stare aster rates tears
alpte	plate petal pleat leapt
ronth	north thorn
latks	talks stalk
oorst	roost roots torso
etser	steer trees terse
ipsne	spine pines penis snipe
wesed	sewed weeds
lifed	filed field
rahms	harms marsh
opsol	spool pools loops sloop
aelks	leaks lakes slake
nacoe	canoe ocean
idets	edits tides deist diets
aocts	coats coast
rohse	horse shore
erfes	frees reefs
epsak	speak peaks spake
aelds	leads dales deals
gnaer	anger range

A GROUP STUDY OF SOME EFFECTS OF PREPARATORY SET

by

ELSA M. SIIPOLA

Although most elementary textbooks emphasize the important rôle played by preparatory set in determining the nature of response, there are really few, if any, satisfactory class-demonstrations available to illustrate the universally recognized effects of set.[1] The present experiment was designed primarily to study the manner in which a specific set, once it has been established, will affect the character of response. From the standpoint of the available possibilities of response, such influences of set may be regarded as selective effects. A secondary point which is demonstrated is that a set established in one situation will, under certain conditions, carry over to a different, subsequent situation.

The general method was as follows. The experiment was conducted as a group study with the class divided into two groups. One group was set to look for words pertaining to *animals or birds* (Group A); the other group was set to look for words having to do with *travel or transportation* (Group T). Several tasks were given to the class as a whole with the hope that the two groups would respond differently in accordance with their different preparatory sets. It was expected that Group A would respond more frequently with words pertaining to animals or birds (A-B words) whereas Group T would respond more frequently with words related to travel or transportation (T-T words). The subjects were kept unaware of the purpose of the experiment throughout by the use of written directions given to each individual. For the sake of making the demonstrations

[1] See the laboratory manuals of Langfeld and Allport, Foster and Tinker, Kline, and Starch. A discussion of these references is included in the article by Rees and Israel in this monograph.

readily usable, the materials and procedure are described in rather full detail.

I. The Selective Effect of Preparatory Sets

The task used in this part was that of perceiving stimulus-words exposed tachistoscopically. The words were projected upon a screen by the use of an ordinary projection lantern directly in front of which was placed a Netschajeff tachistoscope. A series of ten items was used, and each was given a single exposure of approximately .10 sec. followed by a brief interval during which the subject recorded her response. The purpose was that of determining whether the two groups would perceive the same items differently in accordance with their different preparatory sets.

The stimulus-items used are listed below. The series was preceded by the two practice words *ink* and *pillow*.

1. *horse*	6. *monkey*
2. *baggage*	7. *pasrort*
3. *chack*	8. *berth*
4. *sael*	9. *dack*
5. *wharl*	10. *pengion*

It should be noted that four of the test items (1, 2, 6, 8) are real words whereas the other six are ambiguous items which might be seen as either A-B words or T-T words (*e.g., dack* may be seen as *duck* or *deck*). The real words were included to persuade the subjects to expect real words. The word *horse,* which fits under either set, was placed first in order that both sets could operate satisfactorily at the very beginning.

In order to establish the two preparatory sets so that each group would be unaware of the other's set, two sets of direction sheets were prepared with all necessary instructions and spaces for recording the responses. To prevent disclosure of the different sets by casual remarks or questions, a false explanation of the purpose of the experiment was given beforehand and was restated on the direction sheets. The instructor announced that the purpose was that of comparing the perceptual responses of two groups of subjects: a "sophisticated" group instructed as to what the specific nature of the experiment was, and a "naïve"

group kept completely uninformed. Warning was given to the effect that subjects who found themselves to belong to the "sophisticated" group should avoid revealing their knowledge. Actually, every subject found herself a member of a "sophisticated" group and hence kept proudly silent.

Later comments revealed the fact that practically all subjects accepted the false explanation. It is possible that the ruse made the subjects more susceptible to acceptance of the sets since it gave each subject a feeling of having superior status; each felt that she had an advantage over the "poor naïve subjects."

The actual written directions for Group A were as follows: "Ten words will be shown you on the screen. The exposure time for each word will be very short so that you will have to watch the screen closely. Two practice words will be given to help you adjust yourself to the task. Some of the members of the class belong to the 'naïve' group and do not know what the words are about. You belong to the 'sophisticated' group; hence the following information is given you: Most of the words you will see have to do with *animals or birds.* Set yourself accordingly so that you will perceive as many of the words as possible. Do not speak out the answers nor ask questions about the words, for it is important that the 'naïve' subjects get no hint as to the nature of the words. Record below in the proper order the words which you perceive." The directions for Group T were identical except for the substitution of *travel or transportation* in the place of *animals or birds.*

TABLE I

SUMMARY OF GROSS RESULTS

	Group A			Group T		
	Total No.	% of Possible Total	Av. No. per Subject	Total No.	% of Possible Total	Av. No. per Subject
A-B Responses	503	63	6.3	84	11	1.1
T-T Responses	112	14	1.4	594	74	7.4
Other Responses	93	12	1.2	59	7	.7
Omissions	92	11	1.1	63	8	.8

The results given are based upon the data from six laboratory classes including in all 160 subjects, 80 in each of the two groups. The gross results based upon responses to all ten test-items are given in Table I and Fig. 1.

Conclusive proof of the effectiveness of the preparatory sets is furnished by these results. Subjects of Group A perceived six times as many items as A-B words as did subjects of Group T, and subjects of Group T perceived five times as many items as

T-T words as did those of Group A.[2] Further striking evidence of the effective operation of the sets is given by the fact that some subjects in each group perceived all ten items in congruence with the specific set established. Moreover, a large number of subjects, more than a third of each group, failed to perceive any items in accordance with the set of the other group. The last

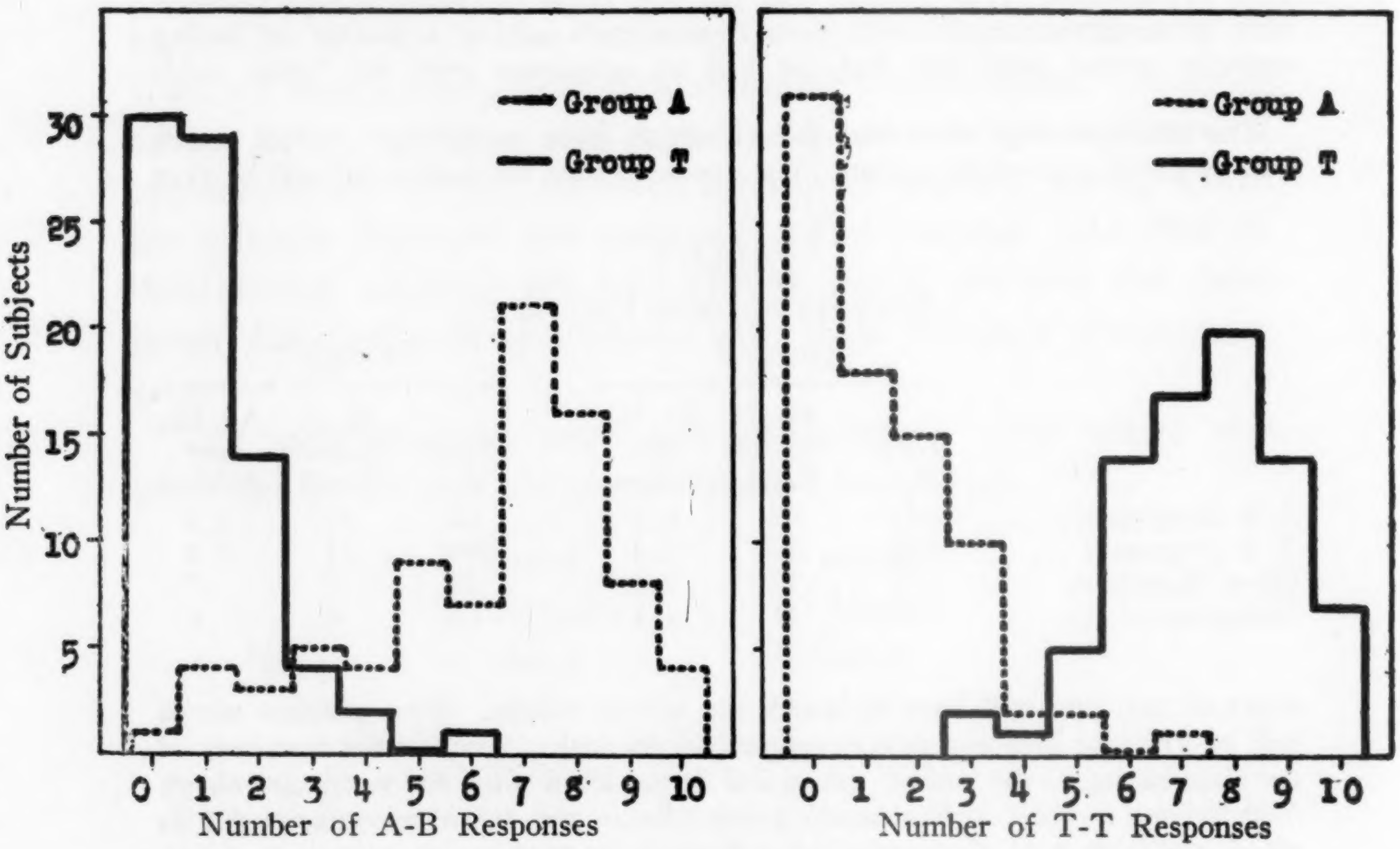


FIGURE 1

Frequency with which Responses of the Two Types (A-B and T-T) Appear for Subjects of the Two Groups.

points are especially significant if one takes into consideration the fact that in the case of four items the stimuli were real A-B or T-T words.

Analysis of the gross results shows to what extent the effects of the sets appear in the case of each separate item. One would naturally expect the results to differ for the various stimuli since the items differed widely in their relations to the two sets. This

[2] The occurrence of a slightly larger number of T-T responses than of A-B responses may be attributed to the fact that three of the stimulus-words (horse, baggage, berth) were directly related to the T-T set, whereas only two (horse, monkey) were related to the A-B set.

is particularly true of the real words; one of them (*horse*) would fit either set, another (*monkey*) was most directly related to the A-B set, the other two (*baggage, berth*) would fit only the T-T set. The ambiguous items could all be adapted easily to either set, although there were undoubtedly intrinsic inequalities in the ease with which individual items could be adapted to a given set.

Table II and Fig. 2 show the extent to which the different types of response (A-B or T-T) occurred for the various stimulus-items. Results for the word *horse* are omitted here

TABLE II

PERCENTAGE * OF A-B AND T-T RESPONSES FOR EACH STIMULUS-ITEM

	Per Cent A-B Responses		Per Cent T-T Responses	
Stimulus	Group A	Group T	Group A	Group T
A-B Word				
monkey	83	35	9	58
T-T Words				
baggage	34	3	28	80
berth	14	1	53	91
Ambiguous Items				
chack	76	4	5	80
sael	64	20	3	53
wharl	45	1	19	73
pasrort	80	25	4	63
dack	80	4	5	94
pengion	63	13	16	63

* In each case the percentage is based upon the total possible number, 80.

since this word was usually perceived correctly, a result which could be interpreted as an effect of either set.[3] That the influence of the sets extended to all of the stimulus-items is proved by the fact that in each case Group A gave more A-B responses than did Group T and likewise Group T always gave more T-T responses than did Group A. If stimulus-items are considered in groups according to kind, one finds that a real word related to the specific set operating gives the highest percentage of A-B or T-T responses, as the case may be (see Fig. 2). The next

[3] For the gross results (Table I and Fig. 1) correct perception of the word *horse* was scored as an A-B response for Group A and as a T-T response for Group T. The subjects in each group insisted that this response was so thought of as to belong under the set operating in each case.

highest percentage of such responses is given by the ambiguous items.

The manner in which the sets operated in the case of the various stimuli may best be seen by examining the actual responses which

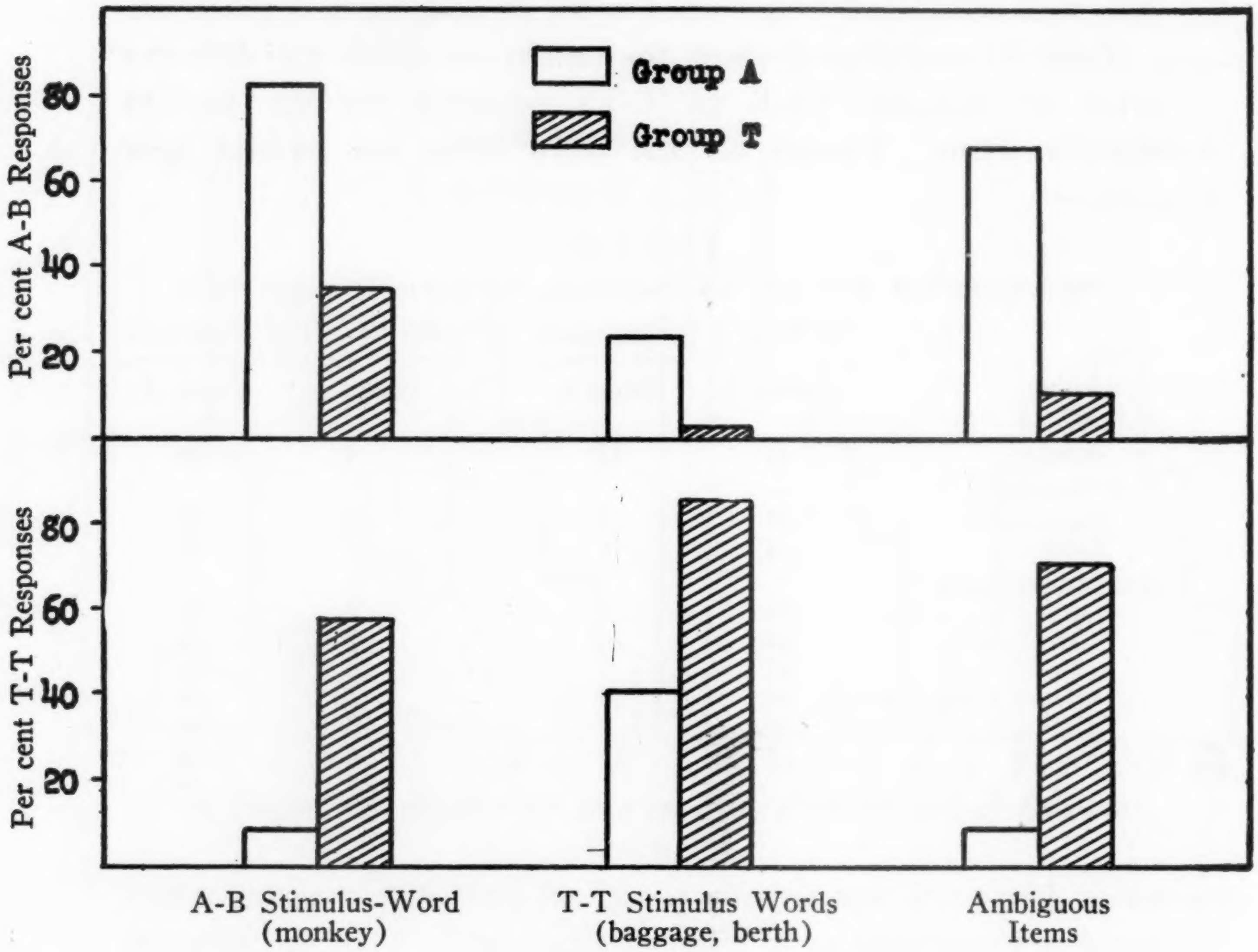


FIGURE 2

Percentage of A-B and T-T Responses for Each Kind of Stimulus-Item.

occurred. Table III shows the most frequent responses, those given by more than five subjects.

In the case of real words as stimuli it is shown that the most frequent response was the correct perception of the word. (There was one exception; Group T gave " money " as the most frequent response to *monkey.*) However, the correct perception of these words was still dependent to some extent upon the relation of the stimulus-word to the set operating. Thus *baggage* and *berth*

were perceived correctly more often by Group T, *monkey* more often by Group A, and *horse* just as often by one group as by the other. When the stimulus-word was related to the set operating, it was perceived correctly by 80 per cent of the subjects on the

TABLE III

FREQUENT RESPONSES GIVEN FOR THE VARIOUS STIMULUS ITEMS

Stimuli	Frequent Responses: Group A	Frequent Responses: Group T	Perceived Correctly: Group A	Perceived Correctly: Group T	Omissions: Group A	Omissions: Group T
Real Words						
horse	horse (66)*	horse (65)	66	65	5	4
monkey	monkey (63) money (7)	money (43) monkey (28)	63	28	4	4
baggage	baggage (22) badger (16)	baggage (54)	22	54	24	15
berth	berth (42)	berth (71)	42	71	14	3
Ambiguous Items						
chack	chick (39) chuck (13) chack (8)	check (51)	8	1	6	3
sael	seal (45)	sail (28) seal (16) seat (6)	5	2	8	6
wharl	whale (25) wharf (13) wharl (8)	wharf (46) wheel (12) whirl (7)	8	2	10	10
pasrort	parrot (59)	passport (42) parrot (20)	1	1	9	6
dack	duck (64) dack (6)	deck (47) dock (24)	6	2	4	0
pengion	penguin (38) pension (11) pigeon (8)	pension (43) penguin (7)	3	2	8	12

* Numbers in parentheses following words indicate the number of subjects (total possible 80) giving those responses. Only responses occurring more than five times are included here.

average. However, a stimulus-word was perceived correctly by only 39 per cent of the subjects when the word was unrelated to the specific set. In the latter case, many of the subjects distorted the word so that it would fit the set operating (*e.g.*, subjects of Group A gave "badger" in response to *baggage*) while others failed to perceive the word at all.

In the case of the ambiguous stimuli there were greater differences between the two groups in regard to the most frequent responses. For no one of these items was the most frequent response the same for the two groups. For two of the items, *chack* and *dack,* the more frequent responses for one group include none of those frequent for the other group. It is obvious that here the influence of the sets was that of causing the ambiguous items to be converted into real words related to the specific set of the subject. The tendency to perceive real words was so strong that correct reports of the actual stimulus were rare (on the average only 4 per cent of the responses to any given item). A striking illustration of what happened in the case of these ambiguous items is given by the responses to the stimulus *dack*: of Group T 89 per cent gave " deck " or " dock " as the response, while only 3 per cent perceived the stimulus correctly; of Group A 80 per cent gave " duck " as the response, while only 7.5 per cent perceived the stimulus correctly.

II. The Effect of an Established Preparatory Set upon a Subsequent Task

The purpose of this part was to find out whether, under certain conditions, the preparatory sets already established for the previous task would carry over to a subsequent task for which no set was prescribed. This problem has been so little investigated and involves such complex conditions that one can have little confidence in planning such a demonstration and in predicting the outcome.

A straightforward approach to this problem would be that of proceeding directly to a crucial task to test for possible effects of the previously established sets. However, to increase the probability of obtaining such effects a special technique was adopted involving the insertion of another task (Task II) before the final test (Task III). Task II, which followed Task I immediately, consisted in finding hidden words in pied type with instructions imposing upon each subject the same set as was prescribed in the first task. The subjects were told that this was a test for speed,

and they were stopped as soon as ten appropriate words had been found. In addition to reinforcing the desired sets, the insertion of this task, it was thought, might accustom the subjects to applying the sets to different materials. It was also hoped that this experience might counteract any tendency to approach each new task as an entirely new and separate experiment, and that it might thus increase the possibility that the subjects would include the new task spontaneously with the former tasks for which an approach had been established.[4]

After spending the few minutes required for Task II, the subjects proceeded to Task III which consisted in constructing words from twenty skeleton-words. The skeleton-words were selected to provide a number of possible solutions, including in each case both an A-B and a T-T word. The extreme flexibility of the material should be noted; most of the skeleton-words had about 10 possible solutions and several had over 20 solutions. Below is given the list with the most obvious solutions fitting the two different sets.

- o a t	goat	boat
s - - l	seal	sail
- - - s e l	weasel	vessel
s - - - p	sheep	sloop
- r - - s e	grouse	cruise
d - c k	duck	deck, dock
m a - -	mare	mail, mast
- u l l	bull, gull	hull
- - b i n	robin	cabin
- a - o o n	baboon, racoon	saloon
- i - e r	tiger	liner, diner
p o - -	pony	port
- - e r	deer	pier
w h a - -	whale	wharf
- a b l e	sable	cable
h o - - -	horse, hound	hotel
- a r e	hare, mare	fare
- - u n k	skunk	trunk
c h - c k	chick, chuck	check
- - - t e r	setter, hunter	porter, waiter

Each subject was given a direction sheet including the list. The directions were the same for both groups, as follows: " Below you will find 20 skeleton-words. Your task is to find real words (not slang nor proper names) which can be made out of the skeleton-words by filling in the blanks. In each case

[4] Experiments of Lewin and Birenbaum are suggestive of the importance of such considerations. *Psych. Forsch.*, 1930, 13, 218–284.

you are to record the *first* real word that you find fitting the requirements, and you are to see how quickly you can solve the 20 items. You are to use your pencil only in recording each word after it has been discovered; do not write anything during the process of solution. Since this is a speed test, fill in the blanks as quickly as possible. Record at the bottom the time which it took you to complete the list." It should be noted that no hint is given in the directions as to the type of words to be looked for, and that no preparatory set is specified. The test was described as a speed test simply to induce the subjects to record the first word found to fit the mechanical requirements.

The results given in Table IV show that three times as many A-B responses were given by Group A as were given by Group T, and that four times as many T-T responses were given by

TABLE IV

SUMMARY OF GROSS RESULTS, SHOWING THE EXTENT TO WHICH THE RESPONSES FITTED THE PREVIOUSLY ESTABLISHED SETS

	Group A			Group T		
	Total No.	% of Possible Total	Av. No. per Subject	Total No.	% of Possible Total	Av. No. per Subject
A-B Responses	722	45	9.0	253	16	3.2
T-T Responses	167	10	2.1	680	43	8.5
Other Responses	680	43	8.5	641	40	8.0
Omissions	31	2	.4	26	1	.3

Group T as were given by Group A. Although these results are not so striking as those obtained for the first task where the sets were directly imposed, they do show that the sets previously established carried over to influence the responses.

Analysis of these gross results showed that the influence of the previous sets extended to each of the twenty skeleton-words in the list. However, great variability was shown in the degree to which the responses to the different items reflected the influence of the sets. The following skeleton-words were least useful from the standpoint of differentiating between the two groups: h o – – –, – r – – s e, – – e r, s – – – p, m a – –, – – – t e r, – a r e, – i – e r. Most of the above items had an exceptionally large number (20–40) of possible solutions, and some of them were intrinsically of such a nature as to lend themselves most readily to solution by words unrelated to either set.

The number of items which individual subjects solved according to the previous sets is shown in Fig. 3. Although the histograms differ greatly for the two groups, it is apparent from the amount of overlapping that some of the subjects were not greatly influenced by the previous sets. To determine why the sets carried over in some cases and not in others would require infor-

mation upon a complex set of influences. Such an analysis would involve consideration of factors such as variation between subjects in the degree to which the sets had really been established by the previous tasks, variations in the manner in which subjects related the new task to the previous tasks, and differences in the method of attacking the new task itself.

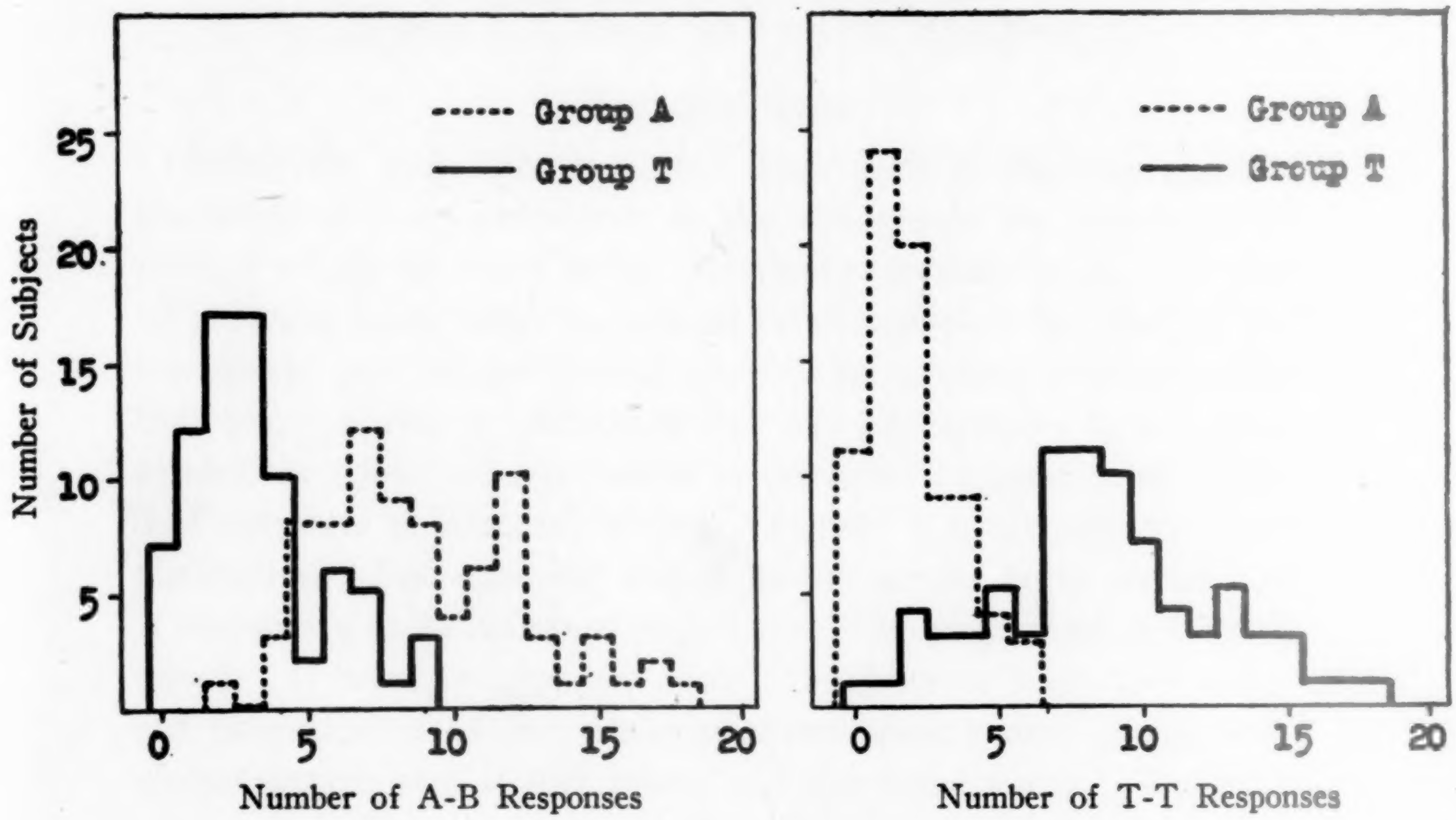


FIGURE 3

Frequency with which Responses of the Two Types (A-B and T-T) Appear for Subjects of the Two Groups.

SUMMARY

A study was made in Part I of the manner in which preparatory sets may determine the character of perceptual responses. Two groups, in which dissimilar sets had been established by instructions, were shown to perceive a common list of stimulus items differently in accordance with the two preparatory sets. The operation of the sets produced effects of the following types: facilitation of correct perception of those stimulus-words which fitted the sets, distortion of irrelevant stimulus-words to form words related to the sets, and conversion of ambiguous items (not actual words) into words appropriate to the sets.

In Part II it was found that under certain conditions preparatory sets which had been established in one task would carry over to affect the performance in a subsequent task for which no set was prescribed. In the completion of skeleton-words, for which there were numerous possible solutions, the subjects of the two groups showed a marked tendency to construct solutions in accordance with their previously established sets.

ORIENTATION IN VISUAL PERCEPTION; THE RECOGNITION OF FAMILIAR PLANE FORMS IN DIFFERING ORIENTATIONS

by

JAMES J. GIBSON AND DORIS ROBINSON

INTRODUCTION

Relatively little attention has been paid in the experimental literature of form-perception to the changes in the nature of the percept which the mere factor of orientation may evoke. A shift of a visual form from its normal relationship to the vertical and horizontal axes of the frontal plane to some other position within that plane makes a difference for the perception; it may even render the form unrecognizable or cause it to appear to all intents and purposes a different object. Figure 1 illustrates the latter possibility. The meaning and character of the form change and it becomes a quite different object when the page is turned upside down. It must be apparent that, for adults at least, two different orientations of the same stimulus-pattern are, under some circumstances and in one sense, not the same form. There are of course forms whose appearance does not change in various positions of rotation about their center, which constitute exceptions to the above rule. Such forms are the circle and other radially symmetrical patterns which look about the same in any position within the frontal plane.

FIGURE 1

(Other examples of this same phenomenon are the letters d and p or q and b.)

Although two different orientations of the same stimulus pattern may yield two psychologically different percepts—even two different shapes—nevertheless they are still the same form in a geometrical sense; the same stimulus-pattern in a physical sense. Internally at least their structure or

interrelationship of parts is identical. Moreover they may be the same form in a cognitive sense: the object in one orientation may often be recognized as the same object when it is upside down or tipped over. Hence we must add to our first statement that two different orientations of the same stimulus-pattern may yield two percepts of the *same* form—the same form in two different positions. This is probably the more common alternative. There is at least an apparent paradox involved in the two statements which rests on different meanings assignable to the word " form." The same stimulus-form may yield one or two perceptual " forms "—two in the case of Figure 1. Clearly no single generalization can be made about the effect of orientation on form-perception. Some forms are not psychologically transposable to any orientation, for they become different " forms "; others are psychologically transposable, remaining the same. The principle of transposability of forms evidently has limits.

It has been frequently observed, without ever having been demonstrated in a clear-cut experimental manner, that children are relatively indifferent to orientation in drawing or reproducing forms and in recognizing or " appreciating " pictures. The evidence of previous investigations is summarized by Rice (4), who reports an experiment of her own designed to discover the age at which a child first sees as different two forms which are identical except for their position on the page. She concludes that orientation first becomes a factor in the perception of forms between the ages of 5 and 6 years.

This indication of the relatively late development of the influence of vertical-horizontal orientation upon form-perception not only serves to emphasize once more the importance of orientation for adult perception but raises the question of whether it is a product of learning or maturation; whether the relationship between an upright form and the vertical-horizontal axes is a matter of past experience or whether there is something perceptually intrinsic or necessary in the relationship.

This experiment aims in the first place to illustrate the importance of orientation for form perception and in the second place to examine the part which may be assigned to learning in the

relation between them. In particular we propose to test the frequency with which forms very familiar in one orientation are recognized as such when disoriented.

In 1899 Dearborn (1) reported an experiment which is related to ours. He showed his subjects, serially, a large number of ink-blots, some of which were repetitions. The task was merely to say whether or not each blot had been seen before. The repeated ink-blots were given in one of a number of possible orientations, either the same, or rotated 90°, 180° or 270°. For the sake of simplicity we shall call these four positions North, East, South, and West, referring to the top of the pattern, although Dearborn uses the notation A, B, C, and D. In addition there were two other orientations: transposed from right to left ("mirror-reversal") and transposed top to bottom ("inverted mirror-reversal"). The results in terms of percentages of correct recognitions are given, together with the percentages which the other positions are of North, taking it as the standard.

	Per cent Correct Recognitions	Per cent of Standard
North (A)	70	100
East (D)	33	47
South (C)	51	72
West (B)	43	61
R to L (R^1A)	46	65
T to B (R^1C)	32	45

Dearborn concludes from his experiment that "an object is recognized more readily when inverted than in either of the two intermediate positions of quarter-reversal" and furthermore that a one-quarter reversal toward the left (W) is more favorable to recognition than a one-quarter reversal toward the right (E) (1, p. 404). He is content to suggest the "great law of habit" as an explanation for these results, as well as for the more obvious result that blots are recognized much less frequently when the orientation has been *changed*. The suggestion is made that familiar objects are more frequently seen in some of these orientations than in others, and that hence some orientations will

be more favorable than others for recognition of ink blots. Dearborn seems to have neglected the fact that it must have been a matter of chance in which of the four possible orientations the original blots were shown. The explanation might be at least logically applicable to familiar shapes, recognition of which would be tested in varying orientations, but not to ink-blots. It is forms-in-certain-positions which are familiar or unfamiliar, recognized or unrecognized, not the positions themselves.

The Experiment

Our present experiment differs from Dearborn's in using familiar shapes, recognizable by the subjects as such, rather than nonsense forms which had been seen only once before. Since it was planned to require subjects to draw what they had seen, in addition to reporting verbally, fairly simple outline forms had to be used; and since it was necessary for the experiment that the familiar forms be ones very seldom experienced in non-normal orientations, the outlines of geographical areas were chosen.

The 12 critical forms selected were the contours of four continents (Africa, Australia, North America and South America), three countries (England, France, and Italy), and five states (Illinois, Louisiana, Maine, New York, and Texas). They were supplemented by 13 nonsense forms of the same general type and size, which were interspersed among the former when the series was exposed. A few of these nonsense outlines were, in irregularity of contour and general appearance, like maps; some contained more straight-line elements and looked more geometrical, some had predominantly curved contours, and others had such shapes as are usually associated with ink-blots. They were introduced in order to prevent subjects from assuming any clear expectation of a certain type of form.

Partly in order to control further the expectation of the subject, and partly to compare the recognizability of familiar outlines *not* customarily seen in only one orientation, 8 more forms were included in the series, making 33 in all. Four of these were outlines of objects which were judged *a priori* to have been seen frequently in many positions: an umbrella (folded), a bone, a key, and the contour of a toy horn or trumpet. These four

were called "poly-oriented" forms. The other four were for comparison, objects of the same sort judged to have been seen predominantly in one position: a cat (sitting), a toy-cannon, a rabbit, and a sunbonnet. They were called "mono-oriented" forms. But in this respect of consistency of orientation they were probably inferior to the geographical forms.

The 33 outlines described were traced in ink on circular disks of heavy white drawing paper, 5.5 cm. in diameter. Each disk could be attached in any position to a rectangular black background, 7 by 9 cm., which fitted behind the window of a Netschajeff tachistoscope. The forms were presented one at a time for a period of about .3 sec. to the subject who sat about 3 feet away. Subjects were not aware of the purpose of the experiment; the instructions simply informed them that some pen-and-ink outlines would be shown, and that they were to draw what they had seen and then write in a few words what the outline had suggested or represented to them if it suggested or represented anything. The first meaning to appear was the important one, not later interpretations which might occur to them on examining the drawing.

Twenty subjects took part in the experiment, divided into four groups corresponding to the four orientations in which the forms were to be shown. These positions were called North, East, South, and West according to whether the top of the form lay at the top, right, bottom, or left. When necessary, a "top" was assigned arbitrarily to a form. Each subject in the North group was shown the 33 forms in their upright position, in the East group the East position, and so on for the others. The series was shuffled and presented in random order to each new subject.

Results

Of the 240 geographical contours, 60 in each orientation, the percentage in each group that were recognized for what they were are given in the first part of Table I. The N-orientation yielded by far the most recognitions, the total for E, S, and W together not equalling N. Taking N as standard, as may be seen in the bracketed percentages, the other orientations give recognitions with only one-fourth to one-fifth the frequency of N. These

proportions in themselves are of little importance, however. The significant fact is that differences can be set up.

Although the results for the poly-oriented and mono-oriented object-forms are not highly reliable, being based on only 80 cases each, 20 for each orientation, it is interesting to note that the poly-oriented forms show differences between the four orientations which are not large and are probably not significant. The mono-oriented object forms, like the geographical forms which are mono-oriented, do show differences. Comparisons between these three kinds of forms must be made with caution, however, since they were not recognizable as such to the same degree, as can be seen by comparing the percentages in the N-orientations.

TABLE I

Percentages of Forms Recognized

Orientation	Geographical forms	Poly-oriented object-forms	Mono-oriented object-forms
North	43.3 (100)*	100	80 (100)
East	11.6 (26.7)	85	35 (43.8)
South	8.3 (19.1)	90	25 (31.3)
West	10.0 (23.1)	100	35 (45.8)

* The percentages in parentheses are calculated on the basis of North=100.

This fact might have some effect on the ratios of frequency of recognition of abnormally oriented forms to frequency of recognition of normally oriented forms.

It should also be pointed out that no significant difference is revealed between the recognizability of these forms in E-, S-, and W-orientation. This is in contrast to Dearborn who believed he had evidence to show that S was most favorable, W next, and E least favorable.

Discussion

Two general problems arise from these results. First, there is the question of why a form in two different orientations is sometimes seen as the same form and is sometimes not seen as the same form but something different. Is this fact merely the result of habit or of past experience? Second, there emerges the problem of explaining the fact that for any one form there is one particular orientation which is the normal one. What part does

past experience play here? We shall take up the two problems in order.

With respect to the rôle which past experience may play in the recognition or non-recognition of the disoriented outlines the data of this experiment are very difficult to interpret. The difference found in our experiment between what we have called mono-oriented and poly-oriented forms (assuming that the latter data are reliable) certainly is related to the difference in the past history of these two kinds of forms. But that this furnishes the whole of the explanation is to be doubted. The fact that a form not normally oriented is sometimes recognized and is sometimes not recognized cannot be wholly ascribed to the influence of past experience. A geographical outline is usually completely unfamiliar when it is rotated. But even though almost never experienced apart from normal orientation, it is sometimes recognized.

Two alternatives may be given to explain why a visual form can be recognized for what it is in any of several orientations: (1) because the form has been perceived in different orientations in the course of past experience—perceived of course as the same thing, not as different things; (2) because it is perceptually the same form in these different orientations *to begin with.* Likewise the same two explanations may be offered to explain why a visual form known in one orientation may be *unrecognized* in others: (1) because it has almost never been experienced in the past in the other orientations—at least as the same thing; (2) because in some sense it is experienced as a different form in those other orientations. The first of the two explanations would be the one used by Dearborn. Against it the argument can be urged that a form cannot have been experienced in different orientations as the same thing without first having been perceived as the same thing in those different orientations. Also the fact that young children seem to identify the differing positions of a form while older children do not is not consistent with the theory that their identity is acquired as a matter of past experience.

Either of these explanations taken alone is probably inadequate. It may well be that they are not as mutually inconsistent as they appear and that in some manner they should be taken as supple-

menting rather than contradicting one another. Certainly the results of the present experiment do not provide any sound basis for adopting one to the entire exclusion of the other.

The general implications of the relationship found between form perception and orientation may be interpreted with more certainty. The disoriented geographical forms, when not recognized for what they were, were frequently recognized as something different, as animals, or " dirt-spots," or " blobs," or " maps "—not any particular map, but simply *a* map. We must conclude that form-perception, at least meaningful form-perception, depends in an important way upon spatial orientation. Orientation is an intrinsic part of the perception—it is internal to perception.

The only useful formula which seems applicable to this relationship of form and orientation is Koffka's conception of the spatial framework (2, ch. V, VI). The framework is the ground on which any figure is seen, considered as having within it a right-left and an up-down, *i.e.,* implicit vertical and horizontal reference-axes. Any perceived form then is a form-in-relation-to-the-spatial-framework; if this relation changes the percept will change. The illustration which is given is borrowed from Kopfermann (3). A square within a rectangular " frame " becomes a diamond when rotated so that its diagonals are vertical and horizontal. But now if the " frame " itself is rotated 45° the diamond becomes, or tends to become, a square again despite the conflicting influence of the margins of the page. Likewise the rotation of the " frame " can make a square look like a diamond, although with less stability.

If now we apply the notion of form in a spatial framework to our own results, the second problem of the two stated at the beginning of this discussion at once arises. What shall we mean by " normal orientation "; more specifically what relationship exists between a form and its spatial framework when the form is normally oriented or upright? In the case of Kopfermann's square the relationship is easily stated: the sides of the form are parallel to the axes of the frame-work. The following assumption might be made: that a form is in normal orientation when

its main lines, especially its base, are congruent with the vertical-horizontal axes of the operative spatial frame, or when alignments within the form made by some of its parts are congruent with the axes. A closely related assumption with possibly different implications would be that a shape is normally oriented when the object corresponding would be in gravitational equilibrium. One or the other of these assumptions fits the facts so well for geometrical forms and for most common objects that it might be concluded that they are universally applicable. Obviously, however, neither is adequate to describe the normal positions of the outlines used in this experiment. The contour of Italy, North America, or Africa, and the contour of such an object as a sunbonnet are clearly in normal orientation when their alignment, to the extent that they have any, is wholly out of parallel with the vertical-horizontal frame. In terms of any angular relationship between parts of the normally oriented form and the framework, these forms are in a purely arbitrary position with respect to it. Consequently there cannot be a universal or structurally logical relationship between a shape and the framework, which necessarily determines what the normal orientation of that shape shall be. For the map-contours of this experiment the normality of the orientation in which they are most readily recognized must be a matter of learning; for geometrical forms and familiar objects it might be a matter of learning. When this fact is taken in connection with the relatively late acquisition by children of discrimination between forms in different orientations, it becomes very plausible to infer at least that learning plays a very important part in making a particular orientation of a shape the unique one in which the shape looks normal.

References

1. Dearborn, G. V. N. Recognition under objective reversal. *Psychol. Rev.*, 1899, 6, 395–406.
2. Koffka, K. *Principles of Gestalt psychology.* New York: Harcourt Brace, 1935. Pp. xi+720.
3. Kopfermann, H. Psychologische Untersuchungen über die Wirkung zweidimensionaler Darstellungen Körperlicher Gebilde. *Psychol. Forsch.*, 1930, 13, 293–364. (Summarized in Koffka, 184f.)
4. Rice, C. The orientation of plane figures as a factor in their perception by children. *Child Develop.*, 1930, 1, 111–143.

ORIENTATION IN VISUAL PERCEPTION; THE PERCEPTION OF TIP-CHARACTER IN FORMS

by

MINNIE RADNER AND JAMES J. GIBSON

INTRODUCTION

Visual forms and objects are characterized by orientation in visual space and this space may be said to constitute for them an orientational frame of reference, or *framework* (3). If we leave out of account the third dimension, considering only forms perceived in the frontal plane, the framework which we need to consider is somewhat simplified, including only the horizontal and vertical directions. Within this frontal plane there generally exists for any particular form an orientation in which the form is visually upright or normally oriented. There may be more than one position in which the form possesses this upright character, as we shall see, but for any form capable of being oriented there is at least one such position. When the form is not in this position, there are two possibilities for the perception: it may be seen as tilted, or inclined, or turned over, or occasionally, as the preceding experiment has demonstrated, the form may be seen as a wholly strange or different object. The character of being abnormally oriented or tipped with reference to the vertical-horizontal axes is the concern of the present experiment.

It became clear in the preceding experiment that the position of normal orientation must be a psychological fact about a visual form, not a geometrical one. A position of abnormal orientation is equally a psychological fact. An object which is tipped has a definite perceptual characteristic independent of its color, movement, and the like, but closely related to its form, which is unrecognized in the usual lists of perceptual qualities. Most of the objects of daily life lack this "tip-character," in other words they are usually upright or normally oriented. An object which

does possess it, such as the leaning tower of Pisa, or an overturned ink bottle, or a picture hung out of alignment, stands out in perception as uniquely and vividly qualified. The disturbance in behavior which may be produced in a person by the perception of the abnormal orientation of all his personal effects and furniture with respect to the framework of his room is known to practical jokers but has been neglected by psychologists. Likewise the problems presented by the visual phenomena of tilt and inclination are presumably dealt with by artists but not yet by psychologists. It is true, of course, that something is known of the mechanism of bodily equilibrium or in other words, the normal orientation of the body with respect to the gravitational axes (1), and it cannot be doubted that the postural vertical thus determined interacts with other factors to determine the visual vertical, *i.e.,* the framework. But the phenomenon of visual uprightness or tip as applied to forms, although dependent upon the perceptual vertical and the processes which determine it, can be investigated separately.

Tip would be an easy perceptual characteristic to deal with if a form were upright in only one of its possible spatial positions and abnormally oriented or tipped in all others. But such a rule does not hold. The phenomenon of tip is dependent on the nature of the form or object in question and varies according to whether the pattern is relatively meaningful or meaningless, and whether the thing or object is or is not subject to the laws of gravitational equilibrium. Percepts like a photograph or portrait, forms of familiar objects such as clocks, animals, or houses, outlines of maps, and figures representing letters and digits are fully upright only in one position, although even here there are positions of the form when it is rotated about its mid-point which are normal as compared to others. We might call them subordinate positions or normal orientation. The outline of a table, for example, is most definitely tipped when it is rotated let us say 25°. When turned through 90° it appears normal in the special sense that its parts are aligned with the vertical and horizontal. When rotated through 180° it is again normal in the additional sense that it appears physically stable. In these two

latter positions the outline might be said to be upright if considered, respectively, as a geometrical form or as a meaningless physical object, but abnormally oriented if considered as a familiar object. Normality of orientation, from which tip is a variant, may evidently be a function of vertical-horizontal alignment, or stability, or merely customary position, of which overlapping criteria the latter is the most general.

Some forms, of course, may have several positions in which they are fully upright in addition to having subordinate positions of normal orientation. An hour-glass has two upright positions with two more subordinate positions, *i.e.,* lying on its side. An ellipse has two upright positions on its side and two more on its end. A square has four upright and four subordinate positions when it is a diamond. Polygons have increasing numbers of normal positions with increasing numbers of sides, and the circle has an infinite number, or better, is not capable of orientation in the frontal plane. Finally, some forms possess weaker orientational character than others, as is illustrated by the "poly-oriented" forms of the preceding experiment and by such generalized perception as "blobs" or "dirt-spots" as were there obtained. Tip-character is evidently related to form in a rather abstruse and complex way and this relationship must be kept in mind.

The Experiments

Part I. The experiments to be reported deal with one aspect of the perception of tip-character in visual forms. The hypothesis with which the first experiment started was that there might be a tendency for forms which are objectively tipped to be perceived and reproduced as upright. One of the writers had noted evidence of such a tendency in an earlier study (2). Perkins reported, among the changes which occurred in his forms, the "verticalizing" of figures or parts of figures that were originally at an angle (4). If this tendency were verified, the further problem would arise as to what conditions are necessary for the subject actually to perceive the tip-character and reproduce it as such.

The forms used in the first experiment were the six relatively meaningless geometrical forms shown in Figure 1. Each form

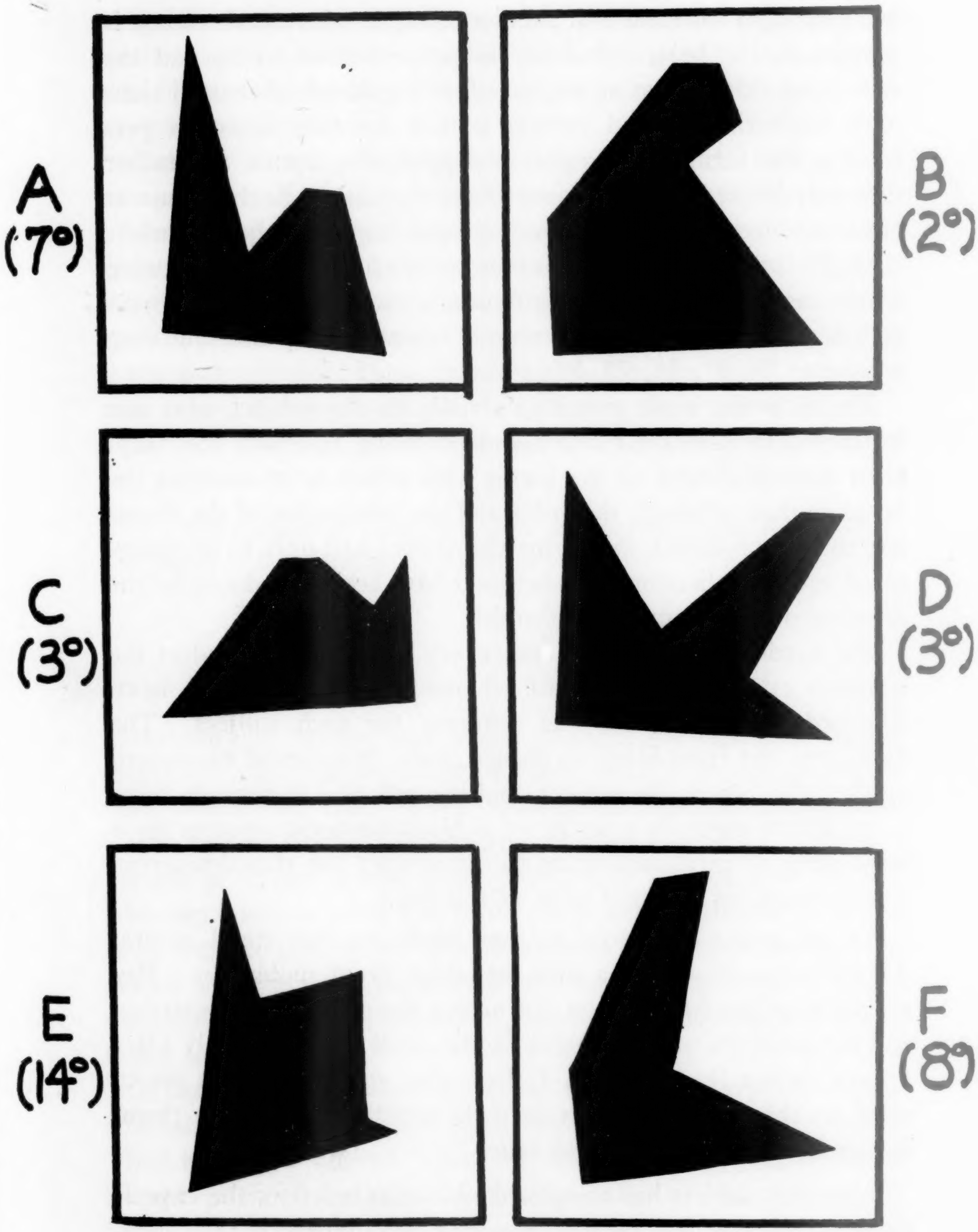


Figure 1
The Stimulus-Patterns of the First and Second Experiments.

has a straight base and 5 or 6 other straight sides of which one is parallel to the base, one other is perpendicular to it, and the remaining sides are at an angle. The alignment of these 3 sides with the horizontal and vertical is thus the only basis for perceiving the forms as upright or tipped; the forms are rather definitely limited in their orientational capacity. Each form was cut from black paper and pasted at some degree of tip on a white card 2½ inches square. In order to emphasize the functioning of the card as a frame for the figure, a narrow black border was added. They departed from normal orientation by the following amounts: 2°, 3°, 3°, 7°, 8°, 14°.

The 6 forms were presented serially to the subject who was instructed to note their order and position. He was then supplied with duplicates of the forms with which to reconstruct the series so that, although the order and the orientation of the forms had to be reproduced, the forms themselves had only to be recognized, and complications which would have been introduced by the drawing of the forms were avoided.

The cards were presented, one every 3 sec., on a stand at the subject's eye level, the removal of one card disclosing the next. The order of the series was different for each subject. The duplicates, cut from black cardboard, were then spread haphazard on the table before the subject, and his task was to arrange them from left to right in a series of 6 black-bordered squares on a large strip of cardboard so as to reconstruct the stimulus-series. The instructions in detail were as follows:

" I am going to expose to your sight on this stand several designs on cards, one at a time, in rather rapid succession. Pay attention as carefully as you can noting the order of presentation and the positions of the designs on the cards. Immediately after I have shown them to you, I shall give you a duplicate set to place on this card from left to right exactly as you saw them. Remember: note *position* and *order*."

When the subject has completed his reconstruction, the experimenter recorded the results, checking orientation with a protractor. The stimulus-cards were then laid on the table for comparison and when no tip was present in the reproduction, the

subject's attention was called to this fact and he was carefully questioned as to whether or not he had originally noticed that the form was tipped. Thirty-one subjects went through the experiment.

Results. Despite the emphasis, twice given in the instructions, on noting the position of the forms, by far the greater number of the reproductions were upright, and most of the subjects were surprised to discover that the forms had been objectively tipped. As may be seen in Table I, 80 per cent of the reproductions were normally oriented and only 11 per cent tipped. The remaining 9 per cent represent those forms which subjects failed to recognize among the duplicates which lay before them and which were either not placed in position or were placed with professions of

TABLE I

THE REPRODUCED ORIENTATIONS OF OBJECTIVELY TIPPED FORMS

Nature of Reproduction	Number of Cases	Per Cent
Upright	148	80
Tipped	20	11
Uncertain	18	9
Total	186	100

uncertainty in orientations which changed the character of the original form. These positions could usually be recognized as ones which we have called subordinate normal orientations. There was no difficulty in deciding whether a duplicate form was upright or tipped; it was either placed with its base quite parallel with the lower edge of the frame or it was unmistakably placed at an angle to the frame. Nineteen or 61 per cent of the subjects placed all of the six duplicates in normal orientation, 9 tipped one duplicate (usually form E), 1 tipped two duplicates, 1 three, and 1 tipped all six.

When reproductions were upright, the subject's reports showed conclusively that the error occurred at the time of perception. They had not "noticed" that the forms were tipped, or (with the exception of the subject who tipped all six) had noticed only that a few forms were tipped. They had interpreted the word "position" in the instructions to mean simply placing the duplicates right side up. On the other hand, the twenty cases in

which the reproductions were tipped were the result of having particularly noted this fact and were usually accompanied by verbal comments such as "tipped," "tilted," or "up a little." Furthermore, in twelve of these reproductions the tip was exaggerated as compared with the original forms, and in only three was it decreased.

Among the six forms used, no clear relationship is to be found between the degree of tip of an original form and the number of times it was seen as tipped. Form E was however the one with the largest tip and also with the weakest orientational capacity, its vertical side not forming a right angle with the base as was the case in the other forms. This form produced the largest number of tipped reproductions.

In general the attitude produced in the subjects by the instructions, even though these stressed "position," was not such as to bring about an active search for tip. Apparently one does not see a nonsense form as possessing tip-character unless there is a strong set to do so. Under the conditions of this experiment, objectively tipped forms are usually perceived and reproduced as upright.

Part II. The experiment was next repeated with instructions which would produce in the subjects an unmistakable set to see the forms as tipped. The expectation was that the subjects would now not only perceive the tip-character but would tend to exaggerate it. Nineteen of the original 31 subjects, selected by chance, were recalled and again presented with the series of six forms. The procedure was the same as in the first experiment except that the subjects were not required to reproduce the order of presentation, which was varied from one subject to the next. The instructions were:

"Last time, you will recall, it was found that none of the designs was placed exactly straight on the card. Now I shall again show you the designs in rather rapid succession. This time pay attention to the amount of tip of each figure. The order will be different but you need not remember the order. Note the amount of tip carefully so that immediately after you

have seen the series you will be able to place the duplicates in precisely the correct positions."

As before, the experimenter measured the reproduced tip with a protractor.

Results. The frequency with which the tip of the stimulus-form was increased, decreased, or unchanged in the reproductions is given in Table II: 58 per cent of the reproductions showed exaggeration of the tip while 12 per cent showed a decrease. No subject reproduced more than two forms at a tip less than that of the corresponding stimulus-form. There is evidently a definite tendency for forms which are seen as tipped to be reproduced with a greater tip than they objectively possess.

Since the six stimulus-forms varied among themselves in the amount of their objective tip, an analysis was made to determine

TABLE II

REPRODUCTIONS OF THE TIP-CHARACTER OF OBJECTIVELY TIPPED FORMS

Type of Reproduction	Number of Cases	Per Cent
Increased	66	58
Decreased	14	12
Unchanged	26	23
Uncertain	8	7
Total	114	100

whether this fact bore any relationship to the frequency with which the tip was increased or decreased in the reproductions. As might be expected there is a rough inverse correlation between amount of tip and tendency to exaggerate it. The three least-tipped forms yielded 77 per cent increased reproductions and 2 per cent decreased, while the three most-tipped forms gave 39 per cent increased reproductions and 23 per cent decreased.

Part III. The results of the second experiment suggested that a more precise quantitative study of error in reproducing the tip of a form should be made. We wished to determine the amount of the constant error of the reproduced tip and discover how it varied with the degree of tip of the presented form. The same form would have to be used throughout, presented and reproduced at varying degrees of tip. A square was employed, tipped to the right by amounts varying from 0° to 45°. At a 45° tip the

square reaches a subordinate position of normal orientation, its diagonals being vertical and horizontal, and beyond that it is no longer tipped to the right but becomes a square tipped to the left.

The material for presentation consisted of thirteen large cards, each with a black 2½ in. square pasted on it at some degree of tip. The cards fitted the exposure-apparatus which was used, a tachistoscope of the shutter type with a 12 in. square window. This opening constituted a framework for the exposed form. The time of exposure was something over 1/10 sec. The thirteen squares bore the following amounts of tip: 0°, 2°, 4°, 5°, 7°, 13°, 15°, 20°, 23°, 28°, 35°, 40°, 45°.

Each subject was given a series of exposures in a different random order, making a reproduction of the perceived tip after each exposure. He had before him a cardboard frame with an adjustable disk pivoted concentrically on it bearing a 2½ in. black square identical with the others. In order to make his reproduction the subject had only to rest this frame squarely on the table in front of him and turn the disk until the black square reproduced the orientation of the one he had just seen. The conditions of reproduction duplicated the stimulus conditions fairly closely. The instructions were these:

"I have a series of similar white cards with black squares on them. The squares are placed at varying amounts of tip. I am going to expose these cards in this window for a very short time, about 1/10 sec. Attend carefully, noting the tip; get a visual image of the figure. Immediately after each presentation, take this adjustable square from the table and adjust the figure so that it will be in exactly the same position as the one you saw. In order to accustom you to the apparatus, I shall expose a few irrelevant cards first. Sit up straight; hold your head straight. Remember: get a visual image of the figure."

The emphasis on obtaining a visual image was intended to discourage any possible tendency to estimate the angle of tip of the figure with relation to the apparatus frame. There was no evidence that any subject did so. All subjects were ignorant as to the purpose of the experiment.

After each adjustment by the subject, the experimenter meas-

ured the reproduced tip with a specially devised protractor which enabled readings to be taken to the nearest degree, and then set the adjustable square back to the zero position for the next trial. In the case of a number of subjects, the experiment was repeated with this variation: before each reproduction the square was set by the experimenter to the *correct* position instead of the zero position and the subject made his reproduction from this starting point, being told that the setting was "approximately correct." The results obtained with this variation were the same as those of the main procedure, the only difference being that absolute

TABLE III

AVERAGES AND CONSTANT ERRORS IN REPRODUCING THE TIP OF A SQUARE AS A FUNCTION OF THE AMOUNT OF TIP PRESENTED

Presented Tip	Av. Reproduced Tip	Constant Error	Number of Subjects
0°	.46	.46	22
2°	7.03	5.03	19
4°	9.55	5.55	22
5°	12.39	7.39	28
7°	12.33	5.33	22
13°	18.18	5.18	28
15°	20.58	5.58	28
20°	23.00	3.00	28
23°	25.59	2.59	18
28°	28.11	0.11	18
35°	33.46	−1.54	28
40°	39.91	−.09	27
45°	41.53	−3.47	18

accuracy was somewhat increased. Therefore, only the results with the main procedure will be given.

The subjects made introspective reports at the end of the series of presentations and occasionally during the series itself.

The number of subjects who went through the experiment was 28. However, some of the thirteen cards with their corresponding degrees of tip were added to the series after the experiment had begun, so that the averages for some positions are based on fewer than 28 subjects. Equating the number of subjects for each position would make no difference in the results.

Results. The average of the reproductions at each position and the constant error of the reproductions at each position may be found in Table III. The data are graphically represented in

Figure 2. The lesser degrees of tip are consistently exaggerated, *i.e.*, are seen as greater than they really are. A zero tip was quite accurately reproduced, but a 2° tip is reproduced on the average as one of 7°, a 4° tip as one of 9°, and a 5° tip as one of 12°.

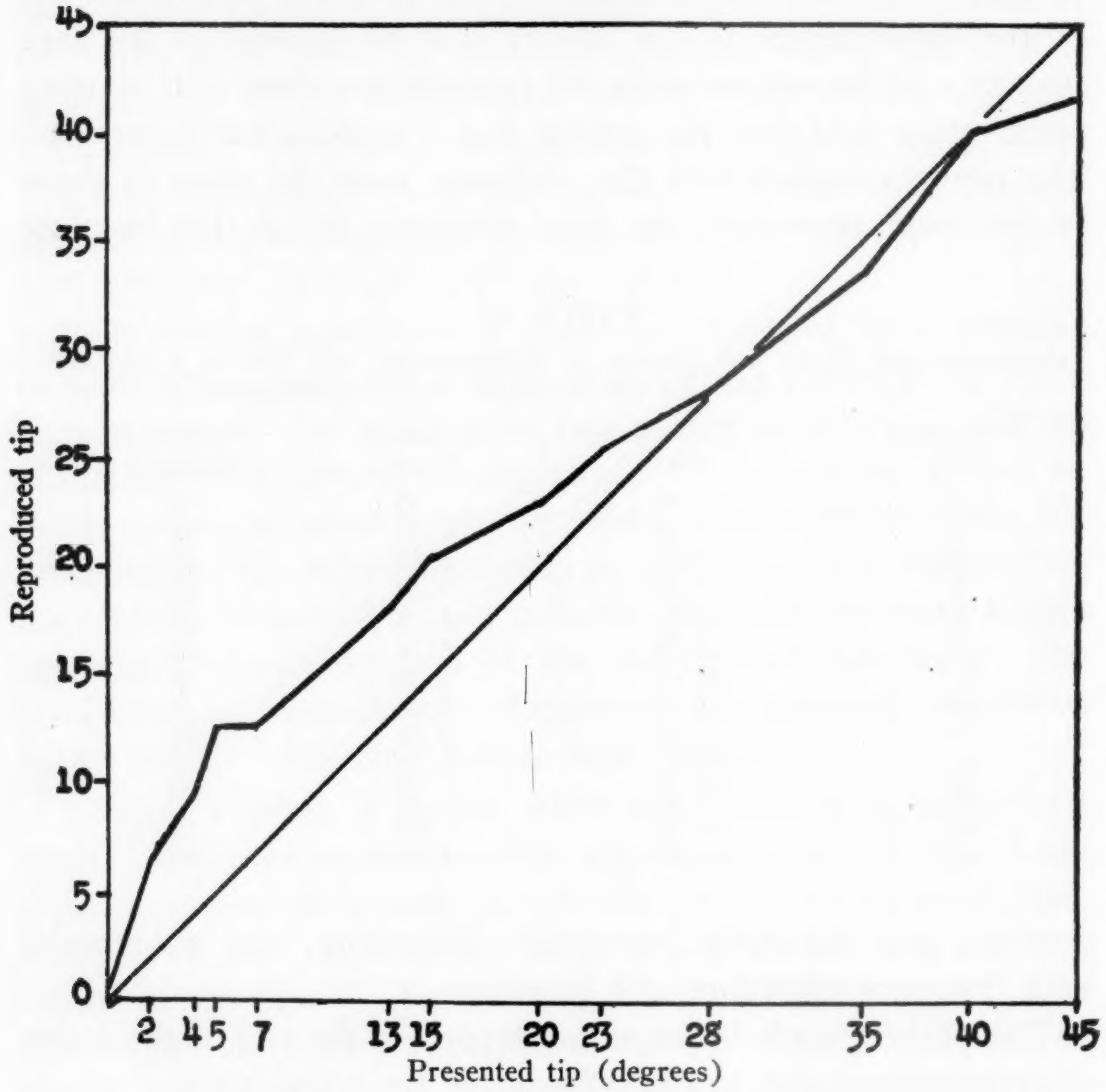


FIGURE 2

Graph of the Average Reproductions Showing the Amount and Direction of Error. (The straight line represents the graph of hypothetically correct reproduction.)

From the 2° position through the 15° position there was not a single case of underestimation of the presented tip; all were exaggerated. Only at 20° and 23° and beyond did reproductions in the direction of underestimation begin to appear.

The exaggeration which is evident in the lesser degrees of tip

apparently decreases and becomes negligible beyond 23°. This point is about midway between the position of the normally oriented square and that of the normally oriented diamond. Whereas all subjects uniformly reported that the forms tipped from 2°–23° were seen as "square tipped to the right" and consistently exaggerated the tip-character, the forms tipped from 28°–45° were described in several different ways and the reproductions instead of being consistent were variable, some subjects increasing the angular degree of tip and some subjects decreasing it. It is of course possible to see a square tipped more than 23° not as a square tipped to the right but as a diamond on its point tipped to the left, and in fact this type of perception was reported by a number of subjects. An examination of the introspective reports applying to the squares tipped 28°–45° revealed that the corresponding perceptions were described in three ways. A few subjects described these forms as squares tipped to the right. This fact is not surprising when it is remembered that the instructions referred to the whole series of forms as squares tipped in varying amounts. A larger group of subjects described the forms on the latter half of the scale as diamonds tipped to the left, or the equivalent. Finally, a third group described these forms in terms which were less uniform and harder to interpret but which could usually be taken to indicate the perception of a diamond or "nearly a diamond." These subjects were aware that a normal orientation was approached at the 45° position. The following report on the series of forms is representative: "Sometimes they don't look as though they were squares. When they are not tipped very much they look off balance, but when they are tipped a great deal they look all right." Another subject used the phrase "almost diagonal" to describe some of the figures.

For the sake of simplicity we shall call these three types of perception of the 28°–45° figures *tipped squares, tipped diamonds,* and *diamonds.* On the basis of the introspective reports an attempt was made to divide the reproductions of these figures into three corresponding groups. In general this meant dividing the subjects into three groups, but not always. When descriptions

were given after individual reproductions they would occasionally indicate that some of a subject's reproductions should be classified as *diamonds* and some as *tipped diamonds.* The three subjects

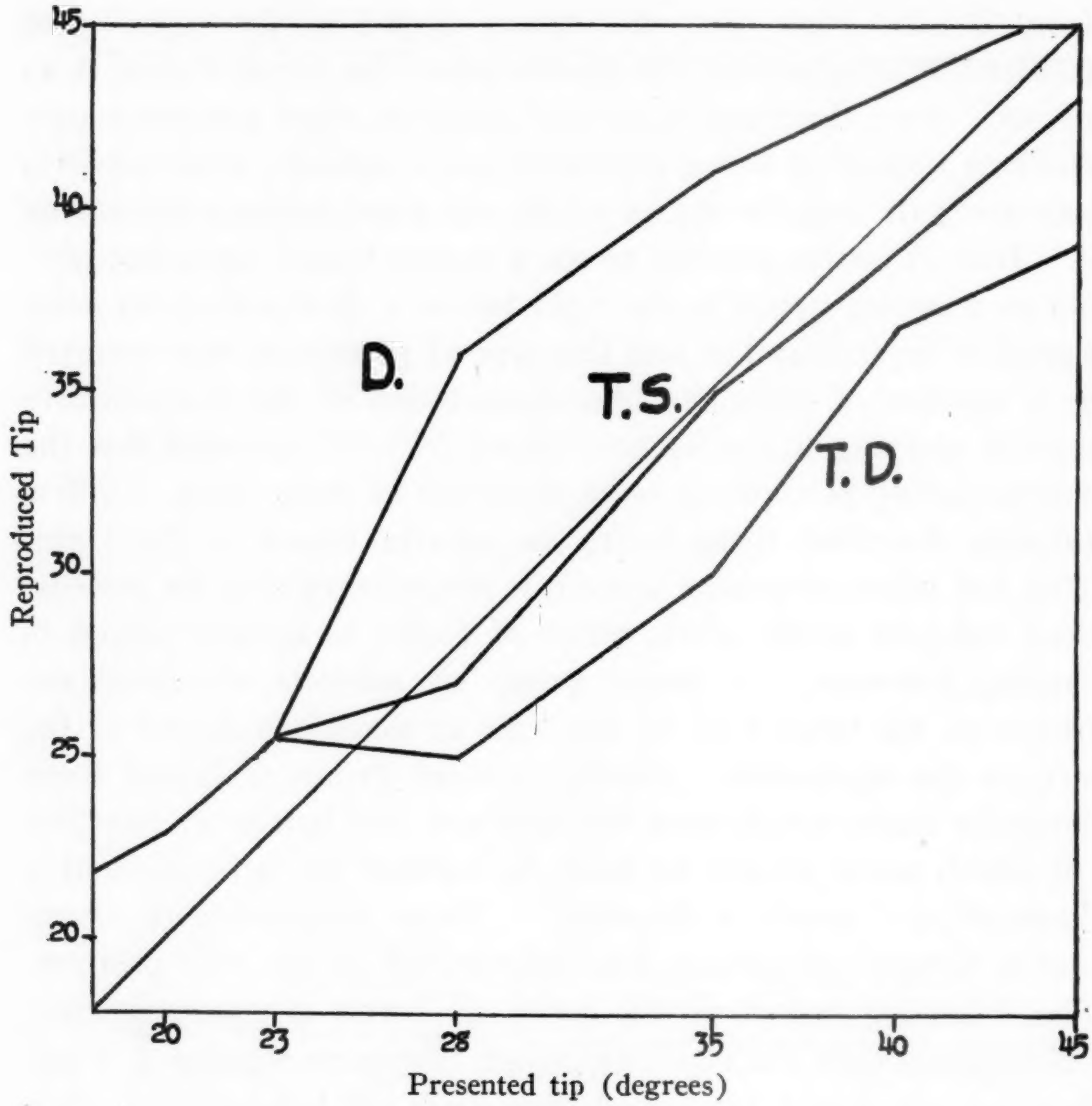


FIGURE 3

Graph of the Average Reproductions of the 23° to 45° Tips According to the Type of Perception. (The straight line represents the graph of hypothetically correct reproductions.)

who saw *tipped squares* were consistent throughout the series. While a classification of this sort is always somewhat dubious because of the possibility of unconscious bias on the part of the experimenter, nevertheless we do not believe that this possibility can wholly account for the results which follow.

Averages were computed separately for the three types of reproductions and the results may be seen in Fig. 3. The letters from left to right indicate the plotted averages of *diamonds, tipped squares,* and *tipped diamonds.*

The subjects who saw the 28°–45° figures as *tipped squares,* like the 2°–23° figures, reproduced them without any significant constant error. The tendency for the tip-character of a form to be exaggerated in perception evidently decreases with greater degrees of tip and becomes negligible beyond 23° so long as the figure is seen as a square tipped to the right. But if at this point it begins to be seen as a diamond tipped to the left, a *tipped diamond,* then it is only to be expected that this new tip-character will itself be exaggerated in perception. In other words, the reproductions will be at smaller angles of inclination from the 0° position, and in fact that is what actually happens. The third possible type of perception seemed to consist in seeing the form as a diamond or "nearly a diamond" apparently without any definite tip-character. In agreement with this characterization, the reproductions are found to be nearer to the diamond-position than were the stimulus-forms. The tip of the form from its position of normal orientation is reduced.

Discussion

Taking the experiments of Parts I, II, and III together, what conclusions may be reached regarding the perception of tip-character in visual forms? In the first place there is evidence that when the observer is not looking for tip-character, a form is perceived without it and the reproduction is upright. It is possible to argue that the tip was merely overlooked, or neglected, or not attended to, but this argument fails to emphasize the fact that the form was reproduced as upright, that this upright reproduction must be an active process, and that there must be a reason for its upright character. In the second place there is also evidence that when the observer is set for tip-character, a form is perceived with this quality exaggerated, and the reproduction is tipped more than the original. If we bear in mind the fact that a form can be tipped only by virtue of and in relation to an

upright position and that a form may have more than one such position—the diamond for example in addition to the square—then the results of the third experiment can be interpreted as corroborating these two conclusions. The square seen as tipped showed heightening of the tip-character with moderate degrees of tip, which effect however decreased and became insignificant with greater degrees of tip. A diamond seen as tipped behaved in precisely the same manner if the results plotted in Fig. 3 are to be trusted. Finally a diamond which apparently was seen either as not tipped, or as lacking a precise and clear-cut tip-character ("nearly a diamond") showed a decrease or partial elimination of the objective tip. This outcome is not quite the same as that of the first experiment but the two are consistent with one another.

In more general terms, it is evident that uprightness and tip as characteristics of form-perception are subject to an all-or-nothing principle. There is a strong tendency for a perceived form to be either upright or tipped, with no intermediate stage appearing, no gradual transition from one to the other. If a form is objectively at an angle of inclination to the spatial frame of reference it may be phenomenally upright or nearly so (inclination destroyed or reduced); or it may be phenomenally tipped (inclination increased). Where there exists a geometrical continuity in passing from zero to a high degree of inclination there exists a psychological discontinuity.

This character of psychological discontinuity in the perception of orientation is surely not unique. There are parallels to it, to mention only a few other types, in the perception of color, in the perception of rectilinearity or curvature of a line, probably in the perception of motion or immobility, surely in the perception of shapes and objects; and an analogous effect extends into the field of quantitative and intensive judgment. There is evidence furnished by Turner (5) that a perceived weight may err either in the direction of becoming more unlike or more like a preceding weight depending on whether it was or was not compared to the preceding weight.

If our results have these wider implications, they should be

formulated in more general terms. Let us describe the perceptual fact of a position of normal orientation as a type of *perceptual center,* more specifically as a *center for the perception of orientation.* The seen position of any form depends upon this orientational center and could not exist without it; the tip-character is always a tip with respect to it. The center serves as a landmark or anchorage-point for perception. There are usually several orientational centers in existence for any one form, the effective range of one extending up to or overlapping the effective range of another. One of these centers may be more dominant in its perceptual effects than another; the latter is " subordinate." In this terminology our experimental results may be described by saying that a perceived orientation tends strongly to lie at an orientational center. If however the perception includes the fact that the orientation departs from the center, is eccentric, then this discrepancy itself tends to increase.

This formula in terms of central and eccentric perception is widely applicable, especially if the concept of a perceptual center is taken broadly enough to include standards, norms, ideals, types, stable organizations and the like. That perceptions tend in the direction of centers of one sort or another has been perennially noted (**2**, **3**, **5**). But often it is true that if a perception is characterized by a peculiarity—by its eccentricity with respect to the perceptual center to which it nevertheless belongs—this discrepancy is heightened rather than eliminated. For example, an object may be perceived as a tree or as a crooked tree; a geometrical form may be seen as a circle or as an incomplete circle, as resembling a half-moon or as a half-moon-with-an-indentation, as symmetrical or as asymmetrical. The perceptions in these different cases, together with their respective reproductions, differ from the stimulus pattern in opposite directions. Such phenomena as these may undoubtedly become very complex; centers may overlap with other centers, and some may be subordinate to others. It may be true, moreover, that when we say a perception changes in an eccentric direction it is better to conceive it as really changing in the direction of another very different kind of center

whose norm as it were is abnormality. It might be supposed that a difference-from-a norm displayed by a perception should itself tend to become a normal difference. An example might be the apparent tendency for either the tipped square or the tipped diamond to become as tipped as possible—that is to approximate to the 23° position. But the formula is less in need of logical elaboration than of further experimental test.

The conception which has been outlined is related to certain tendencies described by Wulf (6) and more recently reviewed by Koffka (3; 498) which apply to changes in memory for geometrical shapes. Wulf's reproductions in general showed either *sharpening* or *leveling,* by which he meant the exaggerating or the weakening of a peculiarity of a form. He also found a more specific tendency toward what he called *emphasizing,* the exaggeration of an especially noticed peculiarity. If a peculiarity is taken to mean merely a departure from a norm or standard which must be implicit in the perception for the peculiarity to be present, then Wulf's results may be said to parallel those of the present experiment.

The hypothesis of the perceptual center need not in itself contain any implications as to its own nature. It may be regarded both as a perceptual organization which has reached relative stability, and as a habitual mode of perceiving. The relative parts played by dynamical factors and by past experience in determining perceptual change, together with their interrelationship, has yet to be worked out.

Summary

A feature of visual form-perception is the characteristic of being upright or tipped. Forms objectively at an angle are often reproduced as upright but if the tip-character is noticed they are usually reproduced with an exaggerated degree of tip.

The hypothesis is suggested that, with respect to orientation at least, *a percept tends to occur at its perceptual center* but that when a percept is experienced as departing from its center *the eccentricity tends to increase.*

References

1. Dusser de Barenne, J. G. The labyrinthine and postural mechanisms. Ch. 4 in *A handbook of general experimental psychology.* Worcester: Clark Univ. Press, 1934. Pp. xii+907.
2. Gibson, J. J. The reproduction of visually perceived forms. *J. Exper. Psychol.*, 1929, 12, 1–39.
3. Koffka, K. *Principles of Gestalt psychology.* New York: Harcourt Brace, 1935. Pp. xi+720.
4. Perkins, F. T. Symmetry in visual recall. *Amer. J. Psychol.*, 1932, 44, 473–490.
5. Turner, W. D. Intra-serial effects with lifted weights. *Amer. J. Psychol.*, 1931, 43, 1–25.
6. Wulf, F. Über die Veränderung von Vorstellungen (Gedächtnis und Gestalt). *Psychol. Forsch.*, 1922, 1, 333–389.

STUDIES IN MIRROR-DRAWING

by

ELSA M. SIIPOLA

Although mirror-drawing was introduced into experimental psychology more than twenty-five years ago, much information is still lacking for a real understanding of this task and the problems connected with its use. Some of the complexities have been revealed by results obtained in experiments performed in our elementary course. Experiments centered around two problems will be discussed in this paper: (I) a comparison of the relative difficulty of different types of mirror-reversals; (II) a study of the effectiveness of previous observation of mirror-drawing upon later execution of this task.

I. COMPARISON OF DIFFERENT TYPES OF MIRROR-REVERSALS

The purpose of this experiment was to discover whether mirror-drawing under conditions in which movements in both the left-right direction and the up-down (sagittal) direction appear reversed from normal would be more difficult than under conditions in which movements in only one of these directions appear reversed. Three groups of subjects (A, B, and C) performed the task of tracing a pattern under similar conditions except for the position of the mirror. For individuals in Group A, the mirror was placed squarely in front of the subject so that movements in the sagittal direction (up-down movements) appeared reversed in the mirror. For subjects in Group B, the mirror was placed at the left of the subject to produce an apparent reversal of left-right movements. For Group C, a double mirror was used to effect an apparent reversal of both the left-right and up-down directions.

The total number of subjects was 162; 89 in Group A, 39 in Group B, and 34 in Group C. The following arrangement and procedure were kept constant for all of these subjects. The mirror was placed 6 inches from the nearest

edge of the pattern to be traced which was placed at a uniform distance from the subject. A simplified pattern (see Fig. 1) involving only left-right and up-down moves was used in place of the usual star pattern. The subjects were instructed to try for both accuracy and speed. Ten trials with the right hand were given each subject with the time recorded for each trial. In order to reflect the errors within the time scores, movements outside of the double lines were penalized by forcing the subject to return to exactly the same position on the path from which she left it.

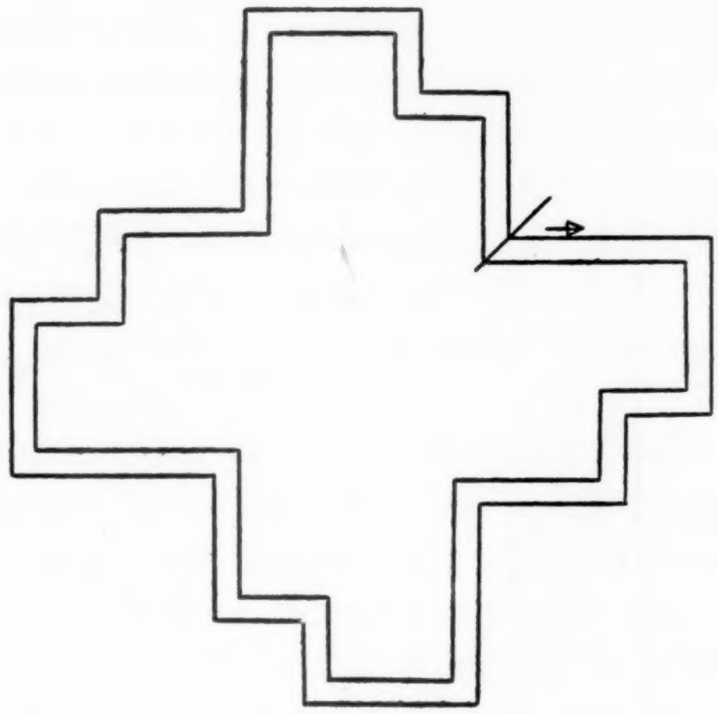


FIGURE 1
Pattern Used for Mirror-drawing.
(Reproduced at one-half the original size.)

For subjects in Group C, the apparatus consisted of two frameless mirrors (7″ x 7″) held in position, at right angles to each other, by a wooden support with converging grooves. When viewed from directly in front, this double-mirror gives three images; in the middle image both the left-right and up-down directions appear reversed. The two outer images were concealed from the subject's view by pasting 2-inch shields on the outer edges of both mirrors.

The quantitative results for this experiment are given in Table I and Figure 2. They indicate that learning to adjust to a situation in which both left-right and up-down movements

TABLE I

SUMMARY OF THE TIME-RESULTS FOR THE DIFFERENT TYPES OF REVERSALS

	Group A	Group B	Group C
Average time for 10 trials................	624 sec.	727 sec.	641 sec.
Median time for 10 trials................	563 sec.	655 sec.	547 sec.
Average time for 1st trial................	130 sec.	163 sec.	133 sec.
Median time for 1st trial................	115 sec.	148 sec.	90 sec.

appeared reversed (Group C) is not any more difficult than learning to adjust to a situation in which movements in only one direction appeared reversed. The results indicate that Group C

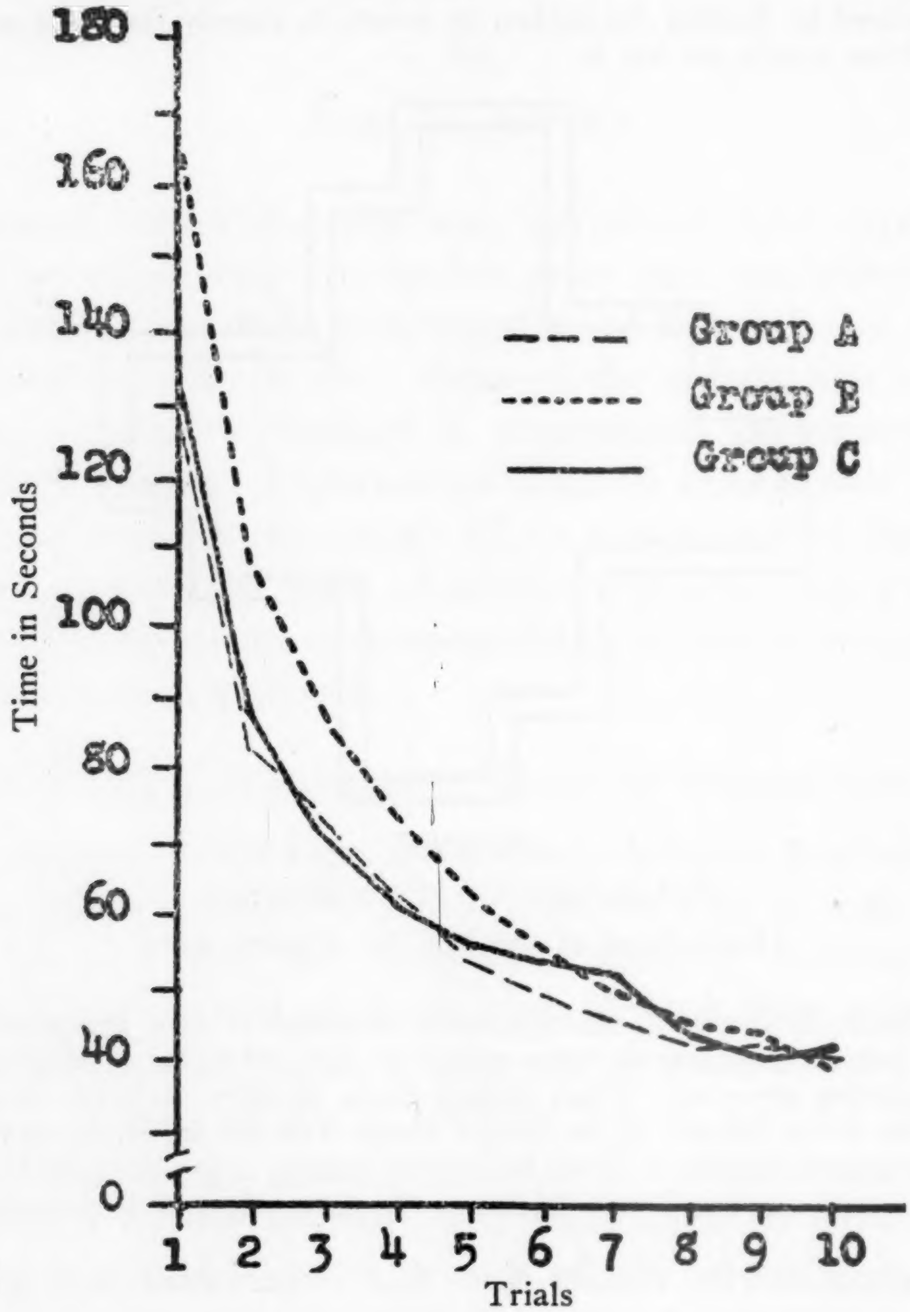


FIGURE 2
Curves Showing the Average Time per Trial for Each of the Three Groups.

was about equal to Group A, and was consistently superior to Group B. The slightly inferior results for Group B probably represent an artifact, and are attributable to the unnatural conditions under which the subjects in this group were forced to trace

from an image appearing at their left instead of in the usual front position.

These results carry the strong implication that one may not think of the learning process in mirror-drawing simply as one in which just so many previously learned eye-hand coördinations are broken down and relearned. If the process were of such a nature, the double-reversal would have been necessarily most difficult, since in this situation the visual cues for each of the movements were contradictory to the usually appropriate kinesthetic data. To explain why the difficulty of the double-reversal is equal to that of the single-reversals, one would need to know much more about the organization of visual and kinesthetic space under normal conditions as well as under the unusual conditions of the mirror-drawing task.

Before theorizing any further on the basis of the results given, we should discuss their reliability. As is usually true of results in mirror-drawing experiments, ours showed tremendous individual differences within each group. For example, the time taken for the first trial varied from 40 to 291 seconds for Group A, 70 to 402 seconds for Group B, and 50 to 360 seconds for Group C. The total time for the 10 trials also showed great variability: Group A, 255 to 1,216 seconds; Group B, 374 to 1,528 seconds; Group C, 255 to 1,149 seconds. Although the relation between these ranges supports the previous conclusions to a certain extent, it is obvious that our summary results based upon group averages give only a crude and tentative answer to the problem.

The occurrence in mirror-drawing of such tremendous individual differences is in itself a striking fact.[1] In expectation of this large degree of variability and in the hope that we might find some explanation of these differences, the subjects had been encouraged to offer comments after each trial and had been asked to fill in the following questionnaire after the experiment was finished:

[1] For further evidence of the striking individual differences found in mirror-drawing, one should consult the detailed results given by Yoakum and Calfee. *J. Educ. Psychol.*, 1913, 4, 283–292.

1. While learning the mirror-drawing task did you make an analysis of the exact way in which the mirror reversed the spatial relations, or did you find this unnecessary? If, during the learning, you consciously figured out the nature of the reversal involved, explain what it was.

2. If now you were asked to guess which movements appeared reversed from normal in the mirror, what would your answer be? Underline your guess below. If you have no idea of the correct answer, underline the question mark.

Up-Down Left-Right Both Up-Down and Left-Right ?

3. Which moves did you find most difficult?

A careful study was made of these comments of the subjects and of the answers to this questionnaire. The results of this study will be discussed quite fully since they furnish the most interesting findings of this experiment.

TABLE II

RESULTS SHOWING THE FREQUENCY OF DIFFERENT GUESSES IN RESPECT TO THE NATURE OF THE MIRROR-REVERSALS

	Per cent of "Up-Down" Guesses	Per cent of "Left-Right" Guesses	Per cent of "Up-Down and Left-Right" Guesses	Per cent of Failures to Guess
Group A......	*61*	14	14	12
Group B......	5	*64*	21	10
Group C......	12	22	*59*	7

One question for which we were anxious to find an answer was whether the subjects usually figured out the exact nature of the mirror-reversal involved during the learning process, or whether they adjusted their movements to the new situation without recourse to a comparison of mirror space with normal space. The answers to the first point on the questionnaire indicated that the latter method of learning was the usual one. Only 23 per cent of the 162 subjects reported that they consciously determined the nature of the reversal and calculated their moves on that basis. The nature of the usual comments on this point support this datum: "Better to feel than to think"; "Did it all by kinesthetic feeling"; "If I tried to think, I was lost."

Even more conclusive evidence for the lack of "correct" information in regard to the specific nature of the reversals involved was given by the answers to question 2, in which the students were asked to try to guess which of their movements had appeared reversed in the mirror (see Table II). Although

the answers were to be based upon the student's experiences while mirror-drawing, one could not exclude inferences from information (*e.g.*, knowledge of physics) acquired outside of the experiment. Even so, only about 60 per cent of the subjects in each group were able to guess the true nature of the reversal. Most of the remaining 40 per cent made an erroneous guess. Only a few subjects admitted that they had no idea of what the real reversal was; some of these were convinced that there was no reversal at all. A comparison of the type of guess made to the quantitative results obtained in each case indicated that the nature of the guess bore no constant relation to the time results.

It seems difficult to explain why so many of the subjects had misconceptions of the nature of the reversal caused by the mirrors. However, this fact is not so surprising when one considers the peculiarly complicated conditions under which the subjects were required to adjust to a new world of space. For although during the mirror-drawing trials the subjects were functioning in a mirror world to a certain extent (the peripheral part of the field was normal), during the intervals between trials the subjects were behaving in a normal room where all the rules of normal space held. For example, if the subject moved her hands or feet between trials, she found that her visual data corresponded with the normally appropriate kinesthetic data, but in the mirror this was not true.

In view of these conflictful conditions, it is not surprising to learn from the introspective data that during the mirror-drawing itself some of the subjects adopted reference points outside of the mirror, whereas others adopted reference points in the mirror reflection. For example, in the group of subjects using *themselves* as a reference point for their movements (*e.g.*, "It's to my right"; "It's toward me"), some of them thought of themselves as being located in their true objective position whereas others thought of themselves as "turned around" and as located in the illusory position reflected in the mirror. This difference in self-localization would naturally create different phenomenal impressions of the nature of the reversal. For example, under the same external conditions (mirror in front of subject) the

up-down movements would appear reversed to some subjects (reference point, self outside of mirror) and normal to other subjects (reference point, self in mirror). In contrast to the subjects using themselves as reference points, others reported that they used objects (*e.g.*, base of mirror), either in the mirror reflection or outside, as reference points for their movements. Apparently some of these subjects made a definite attempt to dissociate themselves and their kinesthetic experiences from their visual experiences (*e.g.*, "One must forget one's hand and one's self"; "I thought of the pencil moving, not of my hand moving"). These reports show that the different types of adjustment made to the complicated conditions of this experiment demanded different conceptions of the exact nature of the reversal.

The change in the stability of the mirror space during the ten trials of practice also helps to explain the uncertainty found in regard to the nature of the reversal. In agreement with common findings in experiments on spatial disorientation, the subjects usually found that the original experience of chaos finally gave way to a feeling that "everything was normal again." One wonders whether the mirror space would have become stable sooner if the conditions had been such as to prevent the subjects from shifting back and forth between mirror-space and normal space.

Still further insight into the reasons for the mistaken notions in regard to the mirror-reversals was offered by the last point on the questionnaire ("What moves did you find most difficult?"). The answers to this question (given in Table III) show that the most difficult movements for groups A and B were not the expected ones. Instead most of the subjects in Group A (up-down reversal) found left-right movements most difficult, and most of the subjects in Group B (left-right reversal) found up-down movements most difficult. The actual drawings of the subjects supported these data. Since the direction of the movements giving the greatest difficulty was not the same as the direction of the movements reversed by the mirror, it is no wonder that many of the subjects failed to guess the true nature of the reversal. Some of them, thoroughly confused, reported that although they knew the physical nature of the reversal caused by

the mirror, they interpreted their difficulties during the mirror-drawing as indicating that the reversal was really in a different direction.

An explanation of these particular loci of difficulty is not hard to find. The general difficulty in making straight lines was partly a function of the position of the pattern. Even under normal conditions it is difficult to draw straight lines if the paper is placed squarely instead of diagonally in front of one. It was the control and correction of these straight moves that became the major source of difficulty and conflict. Since correction of mistakes in left-right lines involved subtle movements in the up-down direction, subjects in Group A found these corrections extremely difficult, owing to their lack of perfect up-down orientation. Correction of the up-down lines was much easier for them since their left-right orientation was relatively undisturbed. A similar explanation applies to the subjects in Group B; they could not make straight up-down lines

TABLE III

RESULTS SHOWING THE COMPARATIVE DIFFICULTY OF LEFT-RIGHT AND UP-DOWN MOVEMENTS FOR THE DIFFERENT GROUPS

	Per cent of "Up-Down" Answers	Per cent of "Left-Right" Answers	Per cent of "Up-Down and Left-Right" Answers
Group A............	21	78	2
Group B............	70	27	3
Group C............	32	38	30

because of their lack of perfect left-right orientation. Subjects in Group C naturally had about equal difficulty in correcting both up-down and left-right movements.

The actual decision at the corners as to the direction of the specific move to be made seemed to offer less difficulty than did the problem of keeping within the boundaries once the turn was made. This point was indicated by the actual drawings and by comments of the following type: "The difficulty is not at the corners, but after the corner is turned"; "One figures out the corners long ahead of time, then they take care of themselves." Although actually errors were often made at the corners, they did not usually become sources of such intense conflict nor did their correction consume much time.

Before finishing this account of the introspective data, the striking reports offered by the students in respect to their phenomenal impressions of the hand while mirror-drawing deserve mention. That the hand seemed an impersonal hand, no longer "my hand" is indicated by comments like the following: "It feels as if I were pushing someone else's hand"; "It feels like a detached hand"; "I felt as if I were watching someone else's hand"; "It feels like someone else's hand or maybe my left hand." The same impersonal note was present in the comments describing the muscular strains felt in the hand: "The hand is

controlled by something else, not by me"; "It feels as if an outside force were pulling the hand in the wrong direction"; "Something is pulling the hand toward the center."

A possible explanation of this loss of personal feeling toward the hand is offered by Koffka's explanation of why visual body data are normally experienced with the "Ego character."[2] Koffka argues that since visual body data coincide, phenomenally speaking, with the place of other body data (from processes aroused in the intero- and proprioceptors) which form the first material for the organization of the Ego, these visual data are also experienced with the Ego character, "my hand," "my arm." If this theory is correct, it is to be expected that when the visual data no longer agree with the normally appropriate kinesthetic data as in mirror-drawing, the hand no longer feels like "my hand." In this regard it should also be recalled that some of the students no longer considered themselves as a reference point for determining the "in front," "left" and "right," but tried instead to dissociate themselves and their kinesthetic experiences from their visual data.

That the normal visual-kinesthetic system was definitely disrupted in the case of some of the students was dramatically illustrated by their inability to perform everyday motor acts after the experiment. In a few cases this disruption affected even the highly mechanized habit of walking.

It is clear from this account of the introspective data that the tremendous variability of the results and the seeming misconceptions of the nature of the reversals were related to three factors: the variety of adjustments made to the unstable spatial framework caused by the simultaneous (or alternate) presence of two conflictful visual-kinesthetic systems, the changes in the stability of this framework during the ten trials, and the unexpected loci of the major difficulties in tracing the pattern. It seems, therefore, that before real understanding of the mirror-drawing problem can be achieved, more information related to the perceptual aspect of this situation is essential. We need particularly to know more about the organization of visual and kinesthetic space under

[2] Koffka, K. *Principles of Gestalt psychology.* 1935, Chap. 8.

normal as well as under unusual conditions such as those of mirror-drawing.

II. The Effectiveness of Previous Observation Upon Subsequent Mirror-Drawing

The results from other experiments done earlier in our elementary course pertain also to the rôle played by the perceptual aspect of the mirror-drawing task. The specific purpose of these experiments was that of determining the extent to which previous observation of mirror-drawing without actual motor practice would facilitate later execution of the task. Results from a control group and from a group that had previous practice with the other hand were obtained for comparison with the results of the observation group.

The method for these experiments was the same as that described in Part I except that the mirror was always placed squarely in front of the subject and the usual star-pattern was used for tracing.[3]

The specific plan of the experiments was as follows (numbers in parentheses indicate number of subjects):

Right-Hand Experiments

Group A_1 (50)—Control Group—10 trials with right hand.
Group B_1 (33)—Observation Group—observation of 10 trials of right-hand mirror-drawing followed by 10 trials with right hand.
Group C_1 (33)—Bilateral Transfer Group—10 trials with left hand followed by 10 trials with right hand.

Left-Hand Experiments (included to check the Right-Hand results)

Group A_2 (42)—Control Group—10 trials with left hand.
Group B_2 (15)—Observation Group—observation of 10 trials of left-hand mirror-drawing followed by 10 trials with the left hand.
Group C_2 (15)—Bilateral Transfer Group—10 trials with right hand followed by 10 trials with left hand.

The subjects in the observation group were instructed to observe carefully the movements made by their partners so that they would be able to surpass their partners' performances later. They were told to watch the movements in the mirror reflection and were asked to refrain from making practice movements of any kind. The conditions for the test trials were kept as constant as possible for all of the groups concerned.

The results from these experiments are given in Table IV and Fig. 3. Although there was great variation in results within each

[3] The star-pattern required the same distance to be traversed but involved eight fewer changes in direction of movement than did the pattern used in Part I. Comparison of the average total time taken for the two types of pattern (Part I Group A, 624 sec.; Part II Group A_1, 942 sec.) indicated that the star-pattern, involving diagonal moves only, is intrinsically more difficult than the pattern involving only right-left and up-down moves.

group, the differences between the groups were great enough to justify a comparison of group averages. These average group results show that both of the observation groups (B_1 and B_2) were consistently superior to the two control groups (A_1 and A_2). The percentage of gain was identical (21 per cent) for the two observation groups.

Since mere observation without any actual motor practice facilitated later performance of the activity to such a large extent, we have further support here for the important rôle played by perceptual factors in mirror-drawing. Unfortunately no clear

TABLE IV

AVERAGE TIME-RESULTS SHOWING THE PERCENTAGE OF GAIN FROM OBSERVATION AND FROM BILATERAL TRANSFER

	Right-Hand Experiments			Left-Hand Experiments		
	Group A_1	Group B_1	Group C_1	Group A_2	Group B_2	Group C_2
Av. time for 10 trials....	941 sec.	741 sec.	623 sec.	1,067 sec.	844 sec.	570 sec.
Av. time for 1st trial....	275 sec.	170 sec.	110 sec.	302 sec.	186 sec.	84 sec.
Per cent gain*		21	34		21	47

* The percentages of gain are based upon the average times for the 10 trials, with the results of the Control Groups considered as norms.

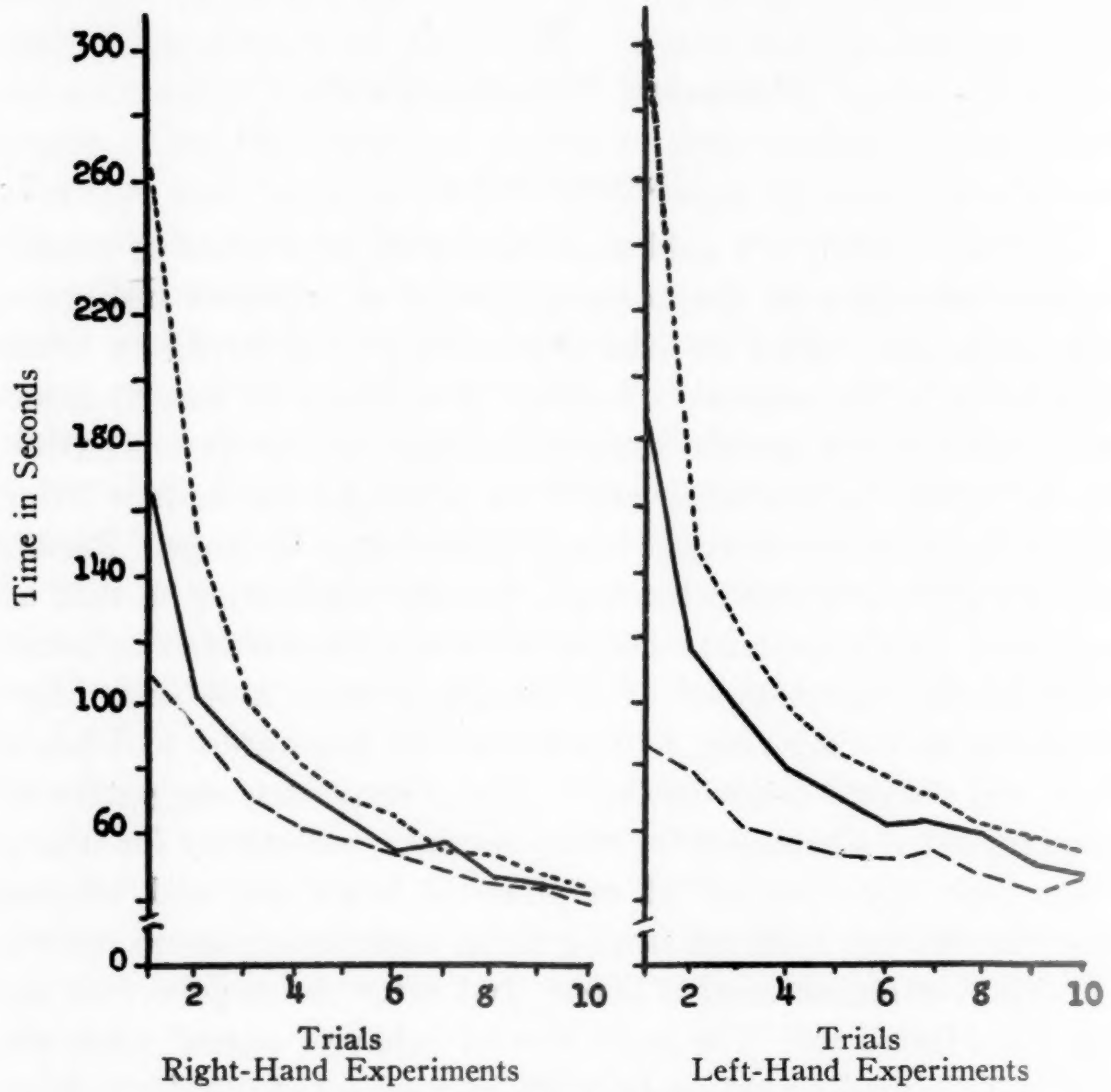
evidence is available to determine whether this gain from observation was due mainly to an adjustment to the mirror world of space during the observation period, or to the perception of useful methods of overcoming the particular difficulties involved.

A comparison of the results for the bilateral-transfer groups with those of the observation groups shows that in both experiments the gain was greater for the former. However, one should note that the gain from bilateral transfer was only 13 per cent higher than the gain from observation in the case of the Right-Hand Experiments which were more reliable. The greater difference in the Left-Hand Experiments was due to the large amount of transfer from the preferred to the non-preferred hand, not to a smaller percentage of gain from observation.[4]

Apparently in mirror-drawing, practice with the bilaterally symmetrical part of the body is superior to observation without

[4] This finding of more bilateral transfer from preferred to non-preferred hand than *vice versa* was also found by Ewert, *Ped. Sem.*, 1926, 33, 235–249.

any actual motor practice, even though the movements and kinesthetic experiences of one hand are not identical to those of the other hand.[5] However, the fact that observation can compete with actual motor practice in later effectiveness is an important



Upper broken line: Control Groups (A_1 and A_2).
Solid line: Observation Groups (B_1 and B_2).
Lower broken line: Bilateral-Transfer Groups (C_1 and C_2).

FIGURE 3

Curves Showing the Average Time per Trial for Each of the Six Groups.

finding in the case of the mirror-drawing task, since it is so often thought of as a task of the strictly motor, trial-and-error type.

[5] That this is not true of all tasks is suggested by experiments of Norcross. His results indicate that observation of a simpler type of task (placing numbers in an adding machine) produced as much gain on the average as did previous practice with the other hand. *J. Comp. Psychol.*, 1921, I, 317–363.

NATIVE FEAR RESPONSES OF WHITE RATS IN THE PRESENCE OF CATS *

by

MARGARET WOOSTER CURTI

INTRODUCTION

In 1920 Griffith (1) published the results of a series of experiments undertaken to find an explanation of apparent instinctive fear responses which he had previously (2) observed in white rats while in the presence of cats. His chief aim was to determine what is the specific sensory stimulus to the fear-behavior. In one series the rats were left in the usual groups in their living cages, and a cat was brought in and placed upon the cage. Results are not given for individual rats, but the implication is that all exhibited " a characteristic cessation of normal activities as measured by the maintenance of a specific posture and such other responses as whimpering, increased rate of respiration and heartbeat, and visceral disturbances." These responses, suggestive of fear, persisted sometimes for many minutes, sometimes for hours. Apparently the increase of respiration, heartbeat, and visceral disturbances was inferred from general observation, as no records of objective measurements before and after the exposure to the cat are referred to. The same sort of behavior ensued when the rats were placed singly or in pairs in a wire cage under a large glass observation frame into which the cat was introduced. When dogs were used instead of cats, the rats were excited, but the characteristic fear responses did not occur, and the report is that the rats resumed their normal behavior as soon as the dog was removed. Other novel stimuli, including various odors and a cloth model of a cat, failed to arouse the " fear."

Griffith states that he established the sense-department involved in several ways. First the cat was placed on a cage when the

* Expanded from a paper read at the meeting of the American Psychological Association, Ithaca, New York, September, 1932.

room was wholly dark; when the light was switched on, the rats were found motionless as before. Second, rats placed in an enclosed space in which a cat had been, responded characteristically; and third, rats also showed striking fear responses to the odor carried on the hands, and to a damp cloth which had been rubbed for some time over a cat. There was no response to a cat enclosed in a glass jar, though she made a variety of movements. One rat considered probably anosmic from a pneumonial affection, and three rats rendered anosmic by cotton stuffed in the nostrils, were undisturbed.

Griffith concludes that "The experiments here reported demonstrate that there is a specific factor, probably olfactory, about the living cat which induces in white rats . . . a marked bodily state . . . suggestive of fear." Later experimenters have referred to Griffith's work as showing that white rats have an innate fear of the odor of cats. Higginson (3), for example, bases a part of his procedure in an experimental study of the effects of emotion on this assumption.

The writer, interested especially in the theoretical implications of Griffith's work, carried out a number of experiments to check his findings. The aim was to determine whether the fear responses described by Griffith would occur in rats exposed for the first time to cats; and if so, whether odors or any other specific stimuli from cats rather than from other animals could be isolated as the "adequate native stimuli" for these responses. The plan was to use rats of different ages to see whether age was a factor in the occurrence of the responses.

In carrying out the initial experiments Mrs. Winifred Day Kirk assisted the writer; and other students helped with the rest of the work. John Powers, a boy now attending high school, loaned his dog for the last series and himself gave intelligent help in carrying it out. The experiments were started in 1931 but most of them were done in 1932.

Method and Treatment of Results

Subjects. Sixty white rats, three tame gray mice, a setter-shepherd pup and several cats and kittens were used as subjects.

The rats varied in age from 4 days to 7 months. With the exception of 12 adult rats kept in separate cages and used either

for breeding purposes or for rough preliminary tests, all the rats were born and brought up in our own laboratory, and cared for by the experimenter or an assistant. The rats were kept on the top floor above the third, and the cats were kept in a basement room. Great care was taken to permit no contact of cats with the rats. During each series one experimenter handled rats only, and one cats only. If a person who had handled cats came to the rat rooms she first changed her dress and scrubbed her hands. While the rats were not under continuous observation from the time of birth they were kept under strictly controlled conditions in a quiet locked room, were well fed and cared for, and were handled very carefully. Up to the time of testing no responses of the type described by Griffith were observed. The plan was to use a rat as subject only once if he showed fear; but if not, in succeeding experiments until he did show fear. Exceptions to this rule are noted.

The cats used to provide stimuli were of four sorts, inexperienced lively kittens, adult mousers, adult well-fed house cats, and adult and very smelly alley cats. In one experiment a partly grown setter-shepherd pup was used to stimulate the rats, and in one series a home-made black cotton cat.

Procedure. There were 5 series of experiments, as follows: (The details of the procedure for each series are given later in connection with a discussion of the results.)

Series I. Natural situation. A rat and a cat were observed together, the rat in a cage and the cat outside, or both placed at the same time on a table top.

Series II. Odor eliminated. The rat was in a cage inside a specially constructed odor-proof glass box in which the cat was placed and where she could move about freely in full view of the rat.

Series III. Odor only. The cat was absent or not visible to the rat at the time of the test, but rats were exposed to a strong cat-odor in several different situations.

Series IV. Stimuli from blows. In this informal test a rat was placed in a cage as in certain other series and observed while

noises were made by striking the cage or the outer box with a stick, no cat being present.

Series V. Responses to dog. In some of the " natural " situations used in Series I, a partly grown setter-shepherd pup was substituted for the cat.

For each series a detailed plan of observation and recording was used, which, with any variations made, is explained in the original records for that series. The general scheme was as follows. The rats were first accustomed to the cage and the place in which the tests were to be made, by being fed there several times before the actual testing began. They were used to being fed once a day, and were tested when active, from a few minutes to not more than 3 hours before feeding time. Each experimental period began with a control period (standard length 5 minutes) during which the rat was carefully observed by two people before the cat or other stimulating object was present. At the end of the control period the stimulus-object was introduced and during the test period (standard length 5 minutes) the observation was continued as before. At the end of the test period the cat was removed quietly by one observer while the other continued her observation. Then the first observer returned and both continued the observation. In case the rat showed no " fear " during the test period he was observed for only one minute following that period; but if he did show " timidity " or fear during the test period the final period of observation was extended until the rat again exhibited normal behavior. Sometimes this after-period lasted as long as an hour or even longer, and in that case the two observers took turns in observing and recording. This was a simple matter as a rat definitely " afraid " according to our definition remained in one position for a long time, and when he started to become active again observation ceased. Rats were identified by notches on the right or left ears, and the referred to as 1R, 1L, 2R1L, etc.

During each of these three observation periods (control, test, and after-periods), detailed written notes were made at the time, independently, by the two observers. Following a chronometer started at the beginning of the period they recorded their observa-

tions in half-minute intervals on specially ruled blanks. A system of abbreviations made rapid recording possible. This careful scheme of recording was not adopted at the very start, when rats were observed together and when general narrative notes were made, but this informal method was used for only a few rats. The informal narrative account had to be used in the last group of tests with the dog, owing to the absence of a second trained observer. Except for this last series the detailed formal notes made carefully in half-minute intervals constitute the main body of data for all the experiments.

In order to lessen the influence of the subjective factor which is especially likely to be present in observing living animals under more or less natural conditions, there was no communication between the two observers until after a test was over. In the first results for series I the two observers had opposite theories as to what would probably happen, Mrs. Kirk expecting that fear would be marked in these situations, the writer expecting to see little or none. In the discussion it is to be understood that the notes of both agree on the results reported, unless the contrary is stated.

The results obtained show so much variability according to the individual and the situation, and so much of their significance lies in the qualitative aspects of the behavior, that any numerical summary of the results, unless interpreted with due caution, is likely to be misleading. Hence only one numerical table is given, to indicate the number of subjects and the general trend of the results. The original detailed notes for each animal in each experiment are on file, as well as fourteen tables summarizing the results for each sub-group in each series.

At the outset of the study we observed cases of the general type of behavior described by Griffith, and the table shows that this fear behavior occurred in all but two of the experimental series planned. A rat would cease all activity, maintaining an attentive attitude at first, with head raised, eyes open, and body in the same position for a long period. Certain rats "froze" while crouching, while clinging to a side wall, or while hovering over a water dish, and the like. After the first "freezing" a rat

would often begin to show a little animation, as by moving his head slightly, lifting a paw, or moving the tail. But he would remain for a long time, from 3 to 30 minutes or longer, *on the same base, i.e.,* without shifting feet or body from the position first assumed. This behavior was quite clear-cut. In the records and the discussion we call it " fear " or, to use Griffith's word which the observers naturally adopted, " freezing." We adopted a strictly objective definition for the purposes of this study, speaking of " fear " when a rat (previously normally active) maintained a fixed position of this type for 3 minutes or longer. This usage is not to be taken as implying that the writer believes that the freezing *is* fear. It is, of course, only one aspect of the total emotional response at any one time; and the emotional response, which follows a temporal course, is to be understood only in relation to the total developing situation of which it is a part. The writer's conception of emotion is a functional one, according to which emotion is defined neither in strictly subjective nor in strictly objective terms, but in terms of the functional relationship of the behavior to the whole situation. The freezing is here selected as an evidence of or " expression "(**5**) of fear simply because it is characteristic, easy to observe, and capable of rather precise objective description. We might say that where we have freezing, there is fear; but we cannot say that there is no fear when freezing is absent.

After the freezing, normal activity would always be resumed gradually: there might be more turning of the head, or a rat might wash his face, or take a few steps to another base where he would remain motionless a while longer, perhaps several minutes longer. After another move another quiescent period might ensue, or several. The first movements were performed in a greatly inhibited manner contrasting strongly with the previous normal behavior. This gradual resumption of normal activity we called " thawing."

We shall now discuss the various series in order.

Series IA. Natural situation, cage on table. In this series an attempt was made to follow Griffith's first procedure. A cat was brought into a special room (where a rat had already been under

observation in a wire cage on a table), and placed on top of the cage. If she jumped down, she was again placed on the cage.* In 1931 the rats were tested in groups of two or three at a time, following Griffith's usual procedure. Only one was tested singly. But it proved very difficult to record the activities of the individual rats; and, too, there was always the possibility that the fear exhibited by a given rat was a response, not to the cat but to the behavior of another rat or rats. Table I, giving results for 1931 and the next year, shows the number freezing. Of the 10 rats tested in groups, 6 which had not frozen in the control period showed marked freezing behavior in the test, after a short period of initial " curiosity responses " to the cat. The duration

TABLE I

SUMMARY OF THE RESULTS OF THE FIVE MAIN SERIES AND THE CHIEF SUB-GROUPS

Series		Description	No. of Rats	No. Freezing	Notes
I	*Natural*				
	A	Cat on cage containing rat	(1) 10 in groups	8	
			(2) 7 singly	1	
	B	Observation box, real cat	11	3	Less sound and movt.
	C	Observation box, artificial cat	8	2	
	D (1)	Cat and rat on table	5	1	1 in obs. box
	D (2)	Cat and rat in observation box	6	0	
II	*Odor eliminated*				
	A	Real cat	(1) 16 rats singly	0	Little movt. by cat
			(2) 3 mice singly	0	
			(3) 3 rats in group	3	
	B	Artificial cat	8	1	Much movt. by "cat"
III	*Odor only*				
	A	Odor from below	4	0	
	B	Odor in outer box	5	0	Rats timid
	C	Control for B. No odor	5	0	Rats timid
	D	Basement room. No odor	3	0	Cautious exploration
IV	*Stimuli from blows*				
	A	Mild and intermittent	9	0	
	B	Intense and repeated	9	6	Same rats as in IV A
V	*Dog as stimulating object*				
	A	In observation box	5	1	
			[4	4]	Rats not naïve—had frozen in IV
	B	In room with rat	5	4	Fear only when dog gave chase

* Regardless of actual sex, in this paper the rat is always referred to as "he," the cat as "she."

of the freezing was from 7 to 36½ minutes. Two other rats had frozen at the beginning of the control period, and required 30 minutes before they became normal enough for the test. They were still timid when the test began, but showed mere curiosity when the cat was put in. Each froze at a point early in the test and remained frozen for over 30 minutes.

In this testing there was a good deal of activity on the part of the cat, an active mouser, and much clattering of the metal hooks of the cage against the metal base pan. Also as the freezing of two in the control periods suggests, the rats had not been, as in later work, thoroughly accustomed to the room before the test.

One animal tested singly in 1931 showed no fear. Six rats were tested in 1932 under much better conditions—singly, after having been fed in the room until thoroughly at home, and with less noise, as the hooks had been tightened. Again an active large mouser was used, but the rats responded very differently from those of the year before. Only one froze, and for just 3 minutes, barely meeting our definition; after that he explored normally. The other rats showed normal behavior, attending to, sniffing or following the cat at times, but neither avoiding her nor remaining quiet.

Series IB. Natural situation, observation box. For some of the 17 rats in the above group sounds made by the cat striking hooks on the cage, by opening doors or clattering of the cage on the metal floor, are recorded, as well as some sudden movements of the observers, made in their efforts to keep the cat on the table. A special observation box was therefore built for use the following year. (See Fig. 1.) It consisted of an elevated wire-netting box, 33 in. high, with a 3-ply wood base 36 x 48 in. Each of the ends is of 3-ply wood, with a glass covered slit 8½ x 1½ in., at such a height that the two observers could watch the animals through it. One of the ends of the box is hinged to serve as a door through which the animals can be introduced. To the middle of the wood floor of the box is clamped an ordinary wire living cage for the rat, with the door at the end nearest the door of the box. Thus a rat can be put into the inner cage and observed during a control period before the cat is placed in the

outer box or on top of the rat cage. Pains were taken to have all doors work smoothly. No metal floor or hooks were present, and noises from the apparatus were thus reduced to a minimum if not eliminated. The whole box was set on a table 30 in. above the floor, and the slits for the observers were 15½ inches

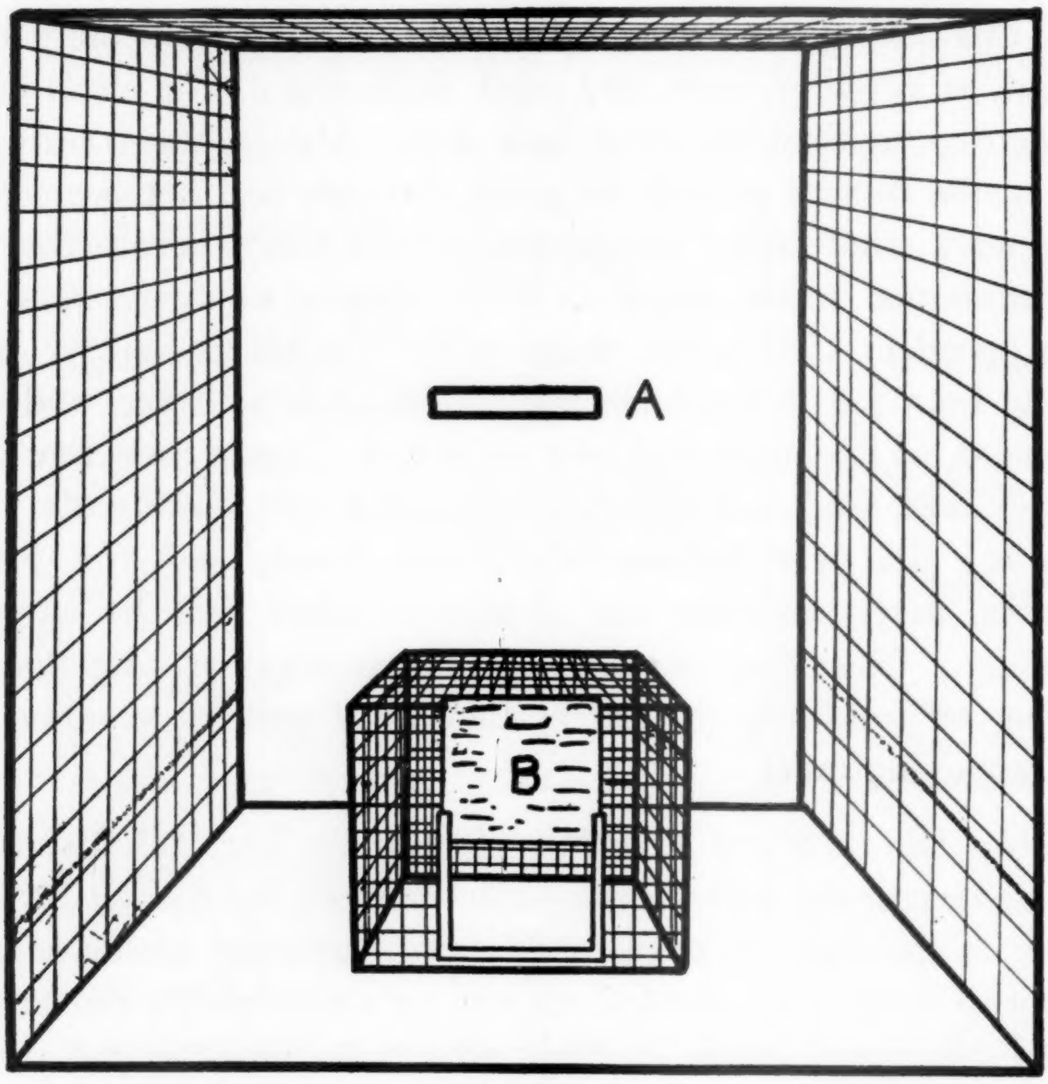


FIGURE 1

Diagram of Observation-Box.

A. Glass-covered observation-slit in wooden end.
B. Sliding door of rat-cage. The wooden front end of the outer box, which contains an observation-slit and serves as a door, is not shown in the diagram.

above the level where the animals were, hence they were not, during the tests, disturbed by the observers.

Under these conditions, which obviated the worst sounds but still permitted much and complex stimulation, while making observation easier, 3 out of 11 rats, or 27 per cent, showed fear, the average duration of freezing being 34 minutes.

In this series (IB) the rather inactive cat produced little noise, and there is evidence in the original notes to suggest that the type of position or movement of the cat was the effective stimulus. In the case of a 5-weeks-old-rat 2L, for example, there was normal exploratory behavior during the control period; and when the cat was introduced into the outer box the rat went toward her, showing apparently normal curiosity. The detailed notes show that the cat miaowed on entering and moved about normally but made neither dashes at the rat nor other aggressive movements. Yet the rat after he approached the cat, moved at once to another corner and stayed there as if transfixed not only for the rest of the 5-minute test period but for 33 minutes after the cat was removed. He retained a characteristic tense position, standing up on his four feet with belly well off the floor, eyes wide open and directed toward the cat while she was present. He maintained the same position, feet not moving at all and only the head turned slightly, occasionally, during the entire period. After 25 minutes he moved his head more freely, and at 39 minutes 45 seconds after he had first frozen, he moved from his base for the first time at the noise of a person walking in the hall, and began to climb up the side of the cage nearest him. He remained in this position for 3 minutes more, his left hind foot high in the wire mesh, and then began to move his head more freely and also his forefeet. Two minutes later he again shifted his forefeet; and, when finally at the end of 47 minutes he started moving freely about the cage, we noted that normal behavior had been resumed, and removed 2L from the cage. This is typical of the freezing behavior shown in those experiments, with a gradual "thawing" at the end. To the human observers the behavior of the rather placid cat seemed mild indeed to cause such a response.

The behavior of rat 2R, also 5 weeks old, contrasts markedly with that above described. Like 2L this rat showed normal exploratory behavior in the control period; but when the cat was put on the cage, instead of retreating, he followed the cat about, climbing up the sides of the cage, poking his nose through the mesh, and sniffing her. When she was taken out he calmly

resumed the exploratory behavior in which he had been engaged before she was brought in. It may be, of course, that the one "miaow" emitted by the cat when put in for 2L could have caused this striking difference, but it seems likely that other factors as well were effective.

Three of the rats in this group (2R2L, 2R, and "Mother") were re-tested 2 months later, and it is of interest that the mother who had shown marked fear in the first test, 4 days after giving birth to a litter of six babies, now showed only a natural curiosity although the cat used as stimulus was much more lively and noisy than the first had been.

Series IC. Natural situation, artificial cat. As a check on the preceding test 8 rats were later observed under the same conditions, except that instead of a real cat a black cloth-and-cotton "cat" was used, manipulated through strings and by hand, by the experimenter (Series IC). The cloth cat was moved slowly most of the time, in an attempt to imitate the stealthy movements of a real cat, and would then be given a quick little jerk. There was no noise at all, though of course to the rats even the movements of the cotton cat might have provided significant auditory stimulation. The movement was of course quite different from the natural movement of a cat; yet it is of interest that it apparently induced fear in much the same way that the real cat did, suggesting that stimuli connected with movement (largely visual presumably), rather than odor or other characteristic stimuli from a cat, may be important in arousing fear.

In this test all the rats showed initial curiosity, and those who did not freeze exhibited unusually lively interest throughout, probably because the movement was more lively and continuous than the real cat usually provided. Two of the 8 subjects froze, but one of these had previously shown fear of the real cat.

Series ID, Groups 1 and 2. Natural situation, cat and rat together. In this series rats were tested singly, each rat being put down with a cat in the same space. In Group 1 they were placed on a large table-top. The cat (a hungry mouser) in most cases showed marked interest in the rat, pawing, playing with

its tail, etc. Of the 5 rats thus tested one froze. The behavior of this particular rat, 2L2R, which was 3½ months old and had had no previous test, stands out as exceptional and very striking.

To quote from the notes—" cat put on table, remains where placed. No noise. As I put rat on table facing cat (uninterested), rat turns and tries to get off. I put him down again headed toward her. Same result. Each of the several times I placed him toward, near, or touching the cat, he ran or trotted away. Cat meanwhile made no move toward him. Removed after 5 min. Very hard to keep rat on table—avoided cat as if automatically."

The next day I placed this rat together with the cat in the outer part of the observation box, where the rat could not get away.

" Rat runs to opposite side of box, stays there, sniffs at cat once as she goes past. (He) goes to other end of box (2 min.) stays there frozen from then on, head up, alert. Washes face once. After 11 min. rat is in same position facing cat who merely lies still, purring. Rat hasn't moved from base though has moved head some. Cat now gets up and stirs, rat attends, turning head, but cat settles down again, rat keeping same position. Marked fear. Both taken out."

This is a nice illustration of Carr's discussion of the dependence of the character of the response on the whole situation (5). When there are no restraining objects, active flight occurs; in a small space where any incipient move to flight would be instantly inhibited, the paralysis of fear occurs instead.

It is to be emphasized that this fear of the cat on the part of a naïve rat was very exceptional. All the other rats in this group showed much curiosity and reacted positively, sniffing the cat, climbing over her and snuggling under her paws. A striking case was that of one rat, 1R, which showed continued curiosity and complete absence of fear even when the cat struck repeatedly at him. We finally removed the rat for fear he would be injured.

In Group 2, to insure continued proximity without the observer having to keep the animals on the table, the rat and cat were put together in the outer part of the observation box. One might expect that where cat and rat were enclosed in a rather small space together, trouble would ensue. Instead, of the 6 " naïve " rats tested in this situation, none showed the slightest fear. We may take the case of 1L as an illustration.

" Rat put in facing cat. They nose each other, cat purring and rubbing against him, bending her head. He runs under and about her. At end of 2 min. they are still playing, but rat now runs about between times exploring

the box. When he gets near her, he sniffs, rears, and noses her. She keeps rubbing at him, bending over. She now purrs and rubs whenever he comes near. At 4 min. she makes a sudden spring at him—he is facing the other way. He turns and plays with her. Just before I take him out at 5 min., cat grasps him and squeezes him in her front paws. He squeaks a little but stays and noses her. She pats him some more. He climbs playfully over her. Is taken out."

The results of this "natural" testing in Series I suggested strongly to the writer that a certain total behavior-attitude on the part of the cat (crouching, with quiet, slow movements), is the essential fear-stimulus, rather than any one specific mode of sensory stimulation. Certainly there is no evidence of an innate fear response to an entirely inactive cat. The results of the series also show marked individual differences in susceptibility to "fear-situations." Whether the observed differences were largely conditioned by innate factors, by special organic conditions, or by the nature of remote or recent experience, is not always clear.

The results demonstrate in a striking way that rats may maintain a definite motor set or posture over a long period of time.

These particular results do not afford any evidence that age up to six months affects the susceptibility to fear of the character of the responses.

Series II. Odor eliminated—Group A, real cat, Group B, artificial cat. For this series an odor-proof box was constructed, with a base of 3-ply hardwood 36 x 49 in. (See Fig. 2.) The sides and top of the box are of glass, the height being 32½ in. The box is elevated 30 in. above the floor. In the center of the wooden bottom is cut a hole 14½ in. square, and above this is built a smaller glass box, 13½ in. high, or a little less than the size of the rats' living cages. The bottom of this inner box is a rectangle of wire mesh with wood edges, hinged so that it can be opened and a rat introduced from below. Thus the rat, in an enclosed cage of about the usual size, is in the middle of a large glass observation box. This box opens at the end by a door 16 in. square into a small adjoining room with a separate entrance. From this room the cat is introduced through the door of the box. During the experiments every possible crack was stuffed with cotton, and since the whole apparatus was very carefully constructed to be airtight, no odor from the cat could possibly

reach the rat, and *vice versa;* yet each animal was, presumably, plainly visible to the other. As explained in the introduction, rats were handled by one person and cats by another, and great care was taken to keep the rat from getting a direct whiff of cat-odor. The cat was carried through the same corridor, but

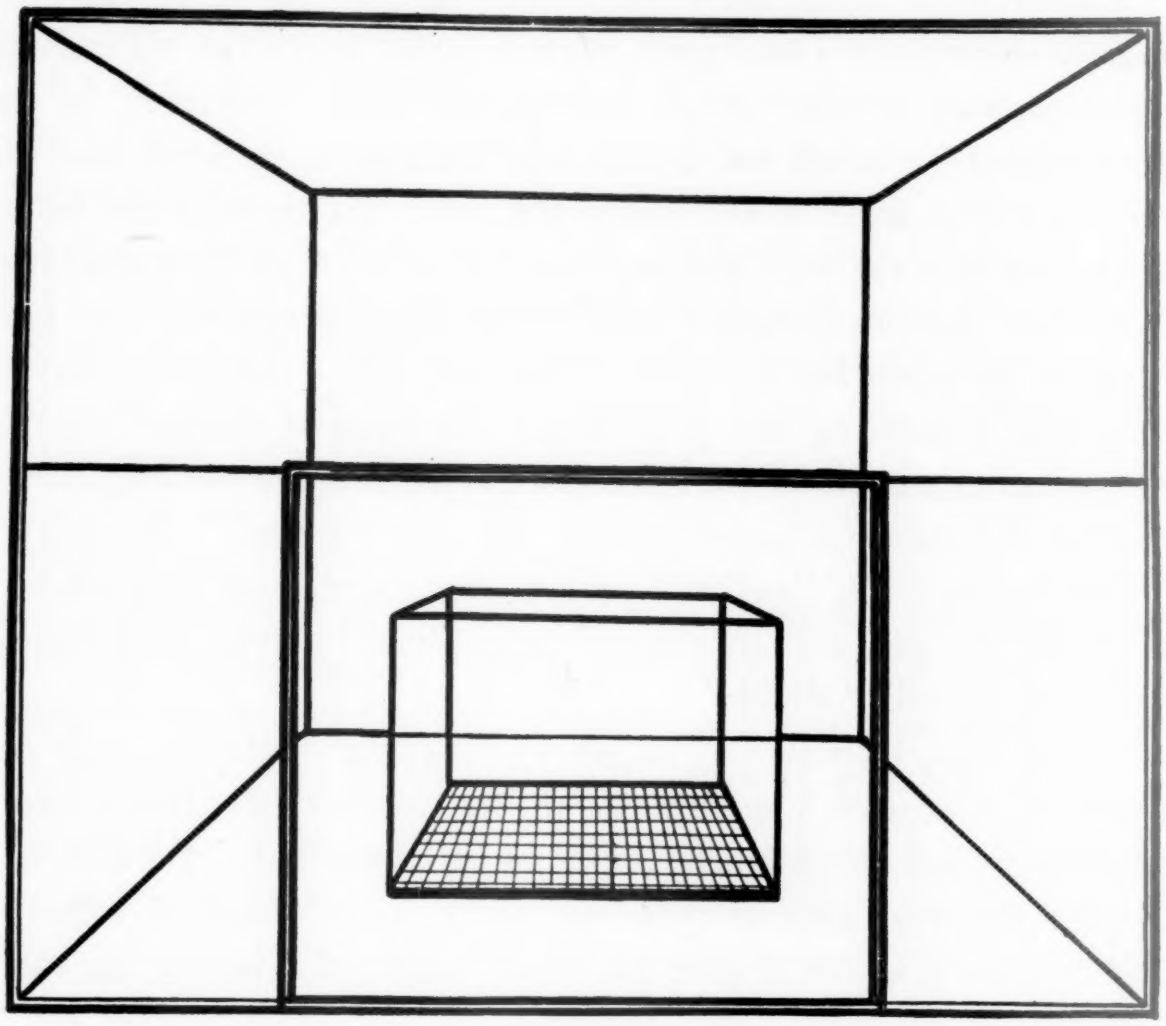


FIGURE 2

Diagram of Odor-Proof Box.

(The box is elevated 30 in. from the floor, the back resting on a table, the front on the ledge of a window opening into the cat-room.)

the rat was not brought through for several minutes later, and the doors of the two respective rooms from which the cat and the rat were introduced into their compartments were kept closed.

It was thought that in the tests the movement of the cats might provoke fear, but unfortunately, in spite of stimulation of the cat by a cotton " spool," and in spite of the use of a mouser previously tested by being fed a white rat when hungry, and of

lively kittens, there was relatively little active movement on the part of the cats, who usually lost interest after the first few seconds or minutes. But they did walk about the outer box, and often paused to 'watch' the rats or even to strike out at them, or to follow them for a few moments.

Under these conditions the results in general were monotonously negative. Three gray mice, and 16 white rats of various ages, showed no fear at all, but usually mild "interest," in the presence of an adult cat which was inactive in general and did no more than walk slowly about the box. At times a cat would strike out at a rat with her paw, or follow a rat as it explored its cage, but these movements were never marked and the rats paid little or no attention to them. One rat, 1L, exhibited behavior very nearly meeting our definition. He showed marked interest in the cat as she twisted and turned preparatory to settling down, and at one time remained frozen for 2¼ minutes. He started at the sound of a class bell outside the room, and also when I removed the cat; and in general he exhibited a type of behavior we came to call "timid."

Three rats 4 weeks old all showed definite freezing, each for a period of at least 4½ minutes, in the presence of a lively kitten which tumbled and bounced about in the outer box. As this was one of the first experiments, the three were observed together and it is not possible to give the exact length of freezing for each, but they all remained quiescent together for 4½ minutes, and it was 11 minutes before any of them actually started moving normally about the case. These rats had not frozen in the control period.

In general, then, only 14 per cent of the 22 animals in this group, all tested for the first time, showed fear, and the fear that did occur was not extreme. But this small percentage of fear-reactions cannot be explained as due to the absence of odor, as other factors in the situation were also very different from the natural situation. There was less movement of the cat, and while the glass permitted vision there might have been a glare which interfered. The presence of the glass certainly interfered with

tendencies on the part of the cats to exhibit their normal attitudes toward the rats.

From the point of view of checking Griffith's hypothesis that smell is the adequate stimulus, Series IIA does afford positive evidence from at least 3 individuals that the smell of a cat is not necessary for the arousal of fear in her presence.

In order to see whether rats in the inner cage would become frozen at all by definite directed movement in the outer box, an artificial cat was substituted for the real one. Eight rats were used as subjects for Group IIB in this experiment. This " cat " was made of part of a cotton bat, covered with black cambric. It was dragged by a string slowly along one side of the box, dangled over the inner box at the end, then drawn slowly, with occasional jerks, to the front again. From that position the experimenter took the cat in her hand and made it strike out toward the rat. All this was done very quietly. Under these conditions one of the rats showed definite freezing, for 40 minutes, and two showed doubtful or timid behavior, responding to the " cat," by following, sniffing, and the like. This result lends weight to the hypothesis that visually perceived movement on the part of the cat may be an important factor in arousing fear.

Series III. Odor only. In this series rats were subjected to the odor of a living cat without any other direct stimulus from her. In IIIA, 4 rats age 2¾ to 6 months were placed together in the inner cage with mesh bottom, and an adult alley cat was brought in and placed not in the box but directly below them. To prevent their looking down and thus getting a visual stimulus a cloth screen was so placed as to prevent direct vision but to permit free circulation of air from below. Under these conditions the rats showed normal behavior during the control period with characteristic sniffing, rearing, etc. In the test period the writer's notes record perfectly normal behavior, similar to the above. The second observer's notes describe one rat's behavior as doubtful. There is no specific record of freezing for this rat.

With the idea that the preceding test may not have furnished a strong enough odor stimulus, another test was carried out at the end of the summer in which an alley cat was first left in the *outer*

part of the observation box for 30 minutes, then taken out, and a rat introduced quickly. After the second rat was tested, the cat was re-introduced for 5 to 10 minutes before the next one was exposed to the odor. For the 5 rats tested in this group (IIIB), both observers record timid and somewhat hesitating behavior, but no cessation of movement. All moved about, though one, more timid than the others, confined his movements to the end of the box near the entrance. It is to be noted that a control period just before the test was not possible in this case, owing to the fact that the outer box had been used all summer for cats as well as just prior to the test. Hence this timidity in a situation entirely new for the rats would be expected in any case. To see whether the "exploratory hesitancy" would be manifest with the cat-odor eliminated, the box was very thoroughly scrubbed a year later, cleaned with lysol solution, and rinsed and dried in a room used for the rats' living quarters. Then 5 naïve rats were introduced singly as before (IIIC). The notes on their behavior by both of the observers are strikingly like those of IIIB the year before, in which a strong cat-odor was present. The rats in IIIC moved about, but stretched, hesitated, sniffed and "listened," as had the rats the year before. There was no fear.

A final test for odor was made in a more natural situation (IIIE). Each of 3 rats was introduced quietly but quickly into the basement room in which all the cats lived during the experiment, the cat having just been taken out. Previous to the actual test for odor (IIID) the rats were introduced singly, as a control, into an unfamiliar basement room where they all showed the cautious exploratory behavior to be expected in a new situation. Introduced into the cat room, the results were clear-cut. There were no signs of fear. As the second observer put it, they seemed if anything more at home here than they had in the room without the cat-odor, showing cautious but active exploratory behavior. The cat-room, darker and more cluttered than the other room, doubtless afforded a more natural environment than the former.

Informal tests were made with other rats which were handled

by the person who had just handled the cat, exposed to cloth rubbed on a cat, etc. All results were negative. Series III shows conclusively that with these rats the cat-odor alone is not a natively adequate specific stimulus for fear responses.

Series IV. Stimuli from blows. This series was run to test the hypothesis that the fear responses shown in the natural situation with the cat on top of the cage, might be due to the sounds or other stimuli produced by the cats in striking hooks which clattered against the metal base of the cage. No cat was used, but rats were placed one at a time in the observation box, and the experimenter operating from the end door of the box struck with a wooden stick the hooks or the base of the cage. Such an experiment could in the nature of the case be only suggestive and not conclusive, since there would be no way of making sure that the sounds artificially produced were like those made by the cat. Moreover, in this informal test neither vision nor the jarring from the blows struck was eliminated. Nevertheless it was interesting to make the discovery that in none of the 9 rats tested could freezing be induced by the type of striking or clattering that seemed to the writer to be like the noises made naturally by the cat (IVA). Only when repeated and heavy blows were struck with a piece of wood (IVB), producing far more intense stimuli than any cat had produced, were definite freezing responses elicited. Even with this extreme type of stimulation only 6 of the 9 rats froze, and the longest duration of freezing was 27 minutes. Three of the rats showed no fear, merely starting or turning their heads when the heavy blows were struck, and maintaining normally active exploratory behavior between blows and after the test.

In the writer's opinion Series IV, though by no means conclusive, lends some weight to the hypothesis that visual rather than auditory stimuli or stimuli from jarring, may well be the more important aspects of the really adequate stimuli for native fear-responses in rats. Of course the series does not prove at all that slight peculiar sounds connected with the movements by the cat (including breathing) may not be important factors in

the fear-arousing situation. An experiment with blind rats is needed.

Series V, A and B. Dog as stimulating object. This series was undertaken to check Griffith's finding that dogs did not elicit the characteristic fear responses in his white rats. First (VA), rats were placed singly in the inner cage of the observation box and a partly grown setter pup placed in the outer box. All the rats which were observed in the control period before the dog was brought in behaved normally in that period. The dog exhibited very lively aggressive behavior, rushed about the box and barked furiously. Five of the rats tested in this series had frozen in IVB (intense sounds), a few days before, and were timid during the control period (one becoming frozen during that period). In spite of this, one of the rats, 1R, showed only curiosity at the barking dog, following and sniffing at him. Two became very timid and inhibited. Their behavior suggested that they would have remained frozen to one spot, had not the violent actions of the dog startled them from it. One case of marked freezing could not be said to indicate fear of the dog, as the freezing occurred in the control period, but another rat (No Mark) showed a very definite first freezing response to the dog.

Of 4 animals which had shown no fear in any previous experiment, 3 showed no freezing in this, though they behaved timidly. One which had shown no fear in IVB (intense and repeated blows) exhibited only curiosity at first but then quickly froze and remained so for 48 minutes. Thus we have in VA only one clear-cut case of a freezing response to a dog in a rat hitherto not afraid; but the behavior of others never before exposed to a dog or a cat (only to the sound of blows), suggests that a dog may be as effective as a cat in arousing fear.

In a final test, VB, 5 rats were brought singly into a room where the dog was held by his owner, and held near the dog. They all sniffed at him and reached or strained toward him. In this situation no rat reacted negatively, but the dog was timid, tending to cower and draw back against his owner—an amusing performance. When the dog was released he approached the rat in each case and soon began to lunge at it and chase it. All 5 rats

showed mere "curiosity" at first, following the dog or side-stepping but not running. All but one, however, very quickly showed extreme fear, reacting by stopping suddenly, transfixed, then dashing behind a chair or other piece of furniture and remaining there motionless for some time after the dog was removed. Of the 4 which finally thus showed fear, 3 had been afraid in IVA or VA. Only one rat, 1R1L, did not become frozen in this test, but he did exhibit greatly inhibited or timid behavior.

Series V shows clearly that a dog may elicit "native fear responses" in rats, and suggests that it is the type of movement rather than sound or smell, that is the "adequate stimulus."

Conclusions

The following conclusions apply to the rats tested in this experiment, and it is reasonable to suppose that, under the same conditions, rats in general would behave similarly.

1. White rats sometimes exhibit characteristic and objectively describable native fear responses in the presence of cats.

2. The odor of a cat is not an adequate specific stimulus for these responses.

3. There is some evidence that a certain type of visually perceived situation involving crouching or other slow movements, in the absence of any intense stimuli of any sort, is a natively adequate stimulus for fear in rats.

4. The experiment with dogs lends weight to the hypothesis that it is the complex movement-situation rather than any specific stimulus from cats, that is the important factor in native fear of cats on the part of rats.

5. In the rats studied, age, within the range 3 weeks to 5 months, does not seem to be an important factor in the fear-behavior.

6. The fact that some rats maintained definite postures for long periods of time is suggestive in connection with experiments on delayed reaction and motor set.

7. These results differ from Griffith's in that unlike him, we found striking individual differences in the behavior of hitherto

isolated rats in the presence of cats, differences connected not only with changes in the stimulating situation but with varying conditions in the rats, such as previous experience in other series.

8. The freezing exhibited by these rats is only one aspect of the total emotional response; in some cases noted in which freezing did not occur there were other " signs of emotion " that could not be so objectively described.

9. These results afford one more bit of evidence for the point long insisted upon by functional psychologists, *viz.*, that an emotion such as fear cannot be defined in terms of definite responses to certain specific stimuli only, but is one aspect of a complex and varying response in a complex and varying situation.

References

1. Griffith, C. R. The instinctive behavior of white rats in the presence of cats. *Psychobiology*, 1920, **2**, 19–28.
2. Griffith, C. R. A possible case of instinctive behavior in the white rat. *Science*, 1919, **50**, 166–167.
3. Higginson, G. D. The after-effects of certain emotional situations upon maze learning among white rats. *J. Comp. Psychol.*, 1930, **10**, 1–10.
4. Carr, H. A. *Psychology*. New York: Longmans Green, 1925. Pp. v+425. (*Cf.* also James, W., *Principles of Psychology*, II, chap. 25.)
5. Carr, H. A. The relation between emotion and its expression. *Psychol. Rev.*, 1917, **24**, 369–375.

PSYCHOLOGICAL REVIEW PUB... WHOLE NO. 210
193...

...hological M...ographs

EDITED BY

† JOSEPH PETERSON, George Pe... College

Studies in Psyc...ogy From Smith Co...ge

This number edite...

JAMES J. GIBS...

...lished for the American Psycholo... Association by
PSYCHOLOGICAL REVIEW ...PANY
PRINCETON, N. ...
and ALBANY, N. ...

Publication[illegible] the
American Psycho[illegible]l Association

EDITED [illegible]

PSYCHOLOGICA[illegible]EW

containing original contributions only, appe[illegible] monthly, January, March, May, July, September, and November, the six nu[illegible] comprising a volume of about 540 pages.

PSYCHOLOGICAL [illegible]ETIN

containing critical reviews of books and a[illegible] psychological news and notes, university notices, and announcements, appe[illegible]thly (10 numbers), the annual volume comprising about 720 pages. Speci[illegible]s of the Bulletin consist of general reviews of recent work in some de[illegible]nt of psychology.

JOURNAL OF EXPERIME[illegible] PSYCHOLOGY

containing original contributions of an experi[illegible] character, appears bi-monthly, February, April, June, August, October, a[illegible]ember, the six numbers comprising a volume of about 900 pages.

PSYCHOLOGICA[illegible]DEX

is a compendious bibliography of books, mo[illegible]hs, and articles upon psychological and cognate topics that have appe[illegible]ring the year. The Index is issued annually in June, and may be su[illegible] for in connection with the periodicals above, or purchased separately.

PSYCHOLOGICAL [illegible]RACTS

appears monthly, the twelve numbers and a[illegible] supplement making a volume of about 700 pages. The journal is devot[illegible] the publication of non-critical abstracts of the world's literature in psycho[illegible]nd closely related subjects.

PSYCHOLOGICAL M[illegible]RAPHS

consist of longer researches or treatises or [illegible]ns of laboratory studies which it is important to publish promptly and as[illegible] The price of single numbers varies according to their size. The Monog[illegible] appear at irregular intervals and are gathered into volumes of about 500[illegible]

JOURNAL OF ABNORMAL AN[illegible]AL PSYCHOLOGY

appears quarterly, June, September, Decem[illegible]arch, the four numbers comprising a volume of 448 pages. The journal [illegible]s original contributions in the field of abnormal and social psychology, re[illegible] notes and news.

ANNUAL SUBSCRI[illegible] RATES

Review: \$5.50 (Foreign, \$5.75). Index: \$4.[illegible] volume.
Journal: \$7.00 (Foreign, \$7.25). Monogr[illegible].00 per volume (Foreign, \$6.30).
Bulletin: \$6.00 (Foreign, \$6.25). Ab[illegible] \$6.00 (Foreign, \$6.25).
Abnormal and Social: \$5.00 (For[illegible]5.25). Single copies \$1.50.
Current numbers: Journal, \$1.25; Review[illegible]; Abstracts, 75c; Bulletin, 60c.

COMBINATION[illegible]S

Review and Bulletin: \$10.00 (Fore[illegible]0.50).
Review and J. Exp.: \$11.00 (Fore[illegible]1.50).
Bulletin and J. Exp.: \$12.00 (Fore[illegible].50).
Review, Bulletin, and J. Exp.: \$16.[illegible]eign, \$16.75).
Review, Bulletin, J. Exp., and In[illegible]9.00 (Foreign, \$19.75).

Subscriptions, orders, and business comm[illegible]tions should be sent to the

PSYCHOLOGICAL RE[illegible]W COMPANY

PRINCETO[illegible] J.

[illegible]CHOLOGICAL MO[illegible]HS

VOL. XXXV.

[illegible] Relativity of Tones. OTTO ORT[illegible] 158. Studies in Psy[illegible] University of Illinois. Pp. 151. [illegible] Comprehensive Units in [illegible]riting. J. W. BARTON. Pp. 45. $.75. [illegible] Experimental Study of [illegible]hology. ELISABETH WHEELER AMEN. [illegible] 160. A Study of [illegible] of American, Mexican, and Ne[illegible] HELEN LOIS KOCH [illegible]. Pp. 116. $1.75.

VOL. XXXVI.

[illegible] of Iowa Studies in Psychology, No. [illegible] by CARL E. SEASHORE. [illegible] 168. University of Iowa Studies in [illegible] No. X. Edited by [illegible] Pp. 114. $1.75. 169. Attitude in [illegible] Learning. ELLEN B. [illegible] $2.25.

VOL. XXXVII.

[illegible] Imagination of Théophile Gautier: [illegible] Literary Psychology. [illegible]NGHAM. Pp. 355. $4.50. 171. An Ex[illegible] Study of Affects and [illegible] to Certain Odors. J. H. KENNETH. [illegible] $1.00. 172. Individual [illegible]agery. CHARLES H. GRIFFITTS. Pp. [illegible]

VOL. XXXVIII.

[illegible] the Purkinje Phenomenon. LOUISE [illegible] Pp. 86. $1.25. 174. A [illegible]y of Chromatic Adaptation. MARY [illegible]ACK. Pp. 118. $1.75. [illegible] Analysis of the Sensori-Motor Con[illegible] of Passive Oscillation: [illegible]ilinear. ROLAND C. TRAVIS and RAY[illegible] Pp. 96. $1.40. 176. [illegible]a Studies in Psychology, No. XI. E[illegible]RISTIAN A. RUCKMICK.

VOL. XXXIX.

177. [illegible]struction in Its Relation to Maze Le[illegible]AN CAMERON. Pp. [illegible] [illegible]ity of Iowa Studies in Psychology, [illegible]shore Commemorative [illegible] by WALTER R. MILES and DANIEL [illegible] $3.50. 179. Time [illegible]. HELEN GRIFFITH. Pp. 82. $1.25. [illegible] Experimental Study of [illegible] Recall in Abnormal Mental Cases. [illegible] Pp. 81. $1.25.

VOL. XL.

[illegible] of Iowa Studies in Psychology, No. [illegible]ited by CHRISTIAN A. [illegible] $2.20. 182. Common Annoyan[illegible] Psychological Study of [illegible] and Irritations. HULSEY CASON. [illegible] $3.25. 183. A Quanti[illegible] Achromatic and Chromatic Sensitivity [illegible]er to Periphery of the [illegible] A. WENTWORTH. Pp. 189. $2.75.

VOL. XLI.

[illegible] Eyelid Reactions to a Light Stimul[illegible] on the Reflex Wink to [illegible] HILGARD. Pp. 50. $.75. 185. The [illegible] Training on Changes [illegible] Achievement. HOMER B. REED. Pp. [illegible] 186. Judging Emotions [illegible]ressions. LEO KANNER. Pp. 91. $1.50 [illegible]versity of Iowa Studies [illegible] No. XIV. Edited by CHRISTIAN A. RU[illegible] Pp. 327. $4.00.

VOL. XLII.

[illegible] of the Lid-Reflex by Voluntarily In[illegible] HELEN PEAK. Pp. 68. [illegible]vestigation of the Responses Made in [illegible] Multiple Choice Maze. [illegible] Pp. 61. $1.00. 190. An Exper[illegible]dy of Apparent Move[illegible] Pp. 91. $1.50. 191. An Objective [illegible] of Concept Formation. [illegible] Pp. 46. $.75. 192. General an[illegible] Attitudes. HADLEY [illegible] $1.50. 193. An Experimental Study [illegible] Recognition. LAURENCE [illegible] $1.75.

VOL. XLIII.

[illegible] of Iowa Studies in Psychology, No. [illegible]ited by CHRISTIAN A. [illegible] $3.75. 195. A Study of a Commu[illegible] Groups and Institu[illegible] of the Behaviors of Individuals. RICH[illegible]ANCK. Pp. 133. $2.00. [illegible] Investigation of Eye Movemen[illegible]rning to Spell Words. [illegible] Pp. 31. $1.50.

VOL. XLIV.

[illegible] of Kansas Studies in Psychology. [illegible]dited by RAYMOND H. [illegible] $2.25. 198. University of Iowa S[illegible] Psychology, No. XVI. [illegible] A. RUCKMICK. Pp. 56. $1.50. 1[illegible]ity of Iowa Studies in [illegible] XVII. Edited by CHRISTIAN A. RUCK[illegible] 123. $1.75.

VOL. XLV.

[illegible] of Iowa Studies in Psychology, No. [illegible]dies in the Psychology [illegible] by NORMAN C. MEIER). Edited by C[illegible] RUCKMICK. Pp. 160. [illegible] Experimental Study of Factors Inf[illegible]onsonance Judgments. [illegible] Pp. 100. $1.50. 202. Binocular and [illegible] Relations in Foveal [illegible] W. COOK. Pp. 33. $1.25. 203. [illegible] and the Learning [illegible] Pp. 115. $1.50. 204. Pra[illegible]riability: A Study [illegible] ANNE ANASTASI. Pp. 55. $.75.

VOL. XLVI.

[illegible]ctions Considered as Conditioned R[illegible] WILLIAM M. LEPLEY. [illegible] A Classified Bibliography on Ps[illegible] MARTIN F. FRITZ. [illegible] The Development of Alfred Binet's [illegible] EDITH J. VARON. [illegible] Autistic Gestures: An Experiment[illegible] Symbolic Movement. [illegible] Pp. 126. $1.75. The Nightmare [illegible] CASON. Pp. [illegible]

American Ps[illegible]chol[illegible] Periodicals

American Journal of Psycholog[illegible]—Ithac[illegible] Y.: Cornell University.
Subscription $6.50. 624 pages ann[illegible] by M. F. Washburn, Madison Bentley, K. M. Dallenbach and E. [illegible]ing.
Quarterly. General and experiment[illegible] [illegible]chology. Founded 1887.

Journal of Genetic Psychology—Worce[illegible] Mass.: Clark University Press.
Subscription $14.00 per year; $7.0[illegible] vol., 1000 pages ann. (2 vols.). Ed. by Carl Murchison. Quarterl[illegible] [illegible]ild behavior, animal behavior, and comparative psychology. Fou[illegible] 1891.

Psychological Review—Princeton, N. J.: [illegible]chological Review Company.
Subscription $5.50. 540 pages annu[illegible]
Bi-monthly. General. Founded 18[illegible] [illegible]dited by Herbert S. Langfeld.

Psychological Monographs—Princeton, N[illegible] Psychological Review Company.
Subscription $6.00 per vol. 500 p[illegible] [illegible]unded 1895. Edited by Joseph Peterson. Published without fix[illegible] [illegible]es, each issue one or more researches.

Psychological Index—Princeton, N. J.: [illegible]logical Review Company.
Subscription $4.00. 400-500 pp. Fo[illegible] 1895. Edited by W. S. Hunter and R. R. Willoughby. An annual b[illegible]aphy of psychological literature.

Psychological Bulletin—Princeton, N. J[illegible]chological Review Company.
Subscription $6.00. 720 pages ann[illegible] Psychological literature.
Monthly (10 numbers). Founded [illegible] Edited by John A. McGeoch.

Archives of Psychology—Columbia Univ[illegible] P. O., New York City.
Subscription $6. 500 pp. per vol. Fo[illegible] 1906. Ed. by R. S. Woodworth. Published without fixed dates, each [illegible]er a single experimental study.

Journal of Abnormal and Social Psyc[illegible]—Eno Hall, Princeton, N. J.
Subscription $5.00. Edited by He[illegible] Moore. Quarterly. 448 pages ann. Founded 1906. Abnormal an[illegible]al.

Psychological Clinic—Philadelphia: P[illegible]gical Clinic Press.
Subscription $3.00. 288 pages. Ed[illegible]ightner Witmer. Founded 1907. Without fixed dates (quarterly). [illegible]genics, psychology, hygiene.

Journal of Educational Psychology—B[illegible]ore: Warwick & York. Subscription $6.00. 720 pages. Monthl[illegible]ept June to August. Edited by Jack W. Dunlap, Percival M. Sym[illegible] and Harold E. Jones. Founded 1910.

Psychoanalytic Review—Washington, D[illegible] 3617 10th St., N. W.
Subscription $6. 500 pages annual[illegible]sychoanalysis.
Quarterly. Founded 1913. Ed. by [illegible] White and S. E. Jelliffe.

Journal of Experimental Psychology—[illegible]ton, N. J.
Psychological Review Company, 90[illegible] annually. Experimental.
Subscription $7.00. Founded 1916. [illegible]thly. Ed. by S. W. Fernberger.

Journal of Applied Psychology—Indiana[illegible] C. E. Pauley & Co.
Subscription $5.00. 600 pages ann[illegible] Founded 1917.
Bi-monthly. Edited by James P. [illegible] Ohio University, Athens, Ohio.

Journal of Comparative Psychology—B[illegible]re: Williams & Wilkins Co.
Subscription $5 per volume of 450 [illegible] Two volumes a year. Founded 1921.
Bi-monthly. Edited by Knight Du[illegible]nd Robert M. Yerkes.

Comparative Psychology Monographs—[illegible]ore: Johns Hopkins Press.
Subscription $5. 400 pages per vo[illegible] Edited by Knight Dunlap. Published without fixed dates, each [illegible] a single research. Founded 1922.

Genetic Psychology Monographs—Worc[illegible] Mass.: Clark University Press.
Subscription $7.00 per vol., one vol[illegible]er year. Ed. by Carl Murchison. Bi-monthly. Each number one com[illegible]esearch. Child, animal behavior, and comparative psychology. Foun[illegible]25.

Psychological Abstracts—Eno Hall, Pri[illegible] N. J. Edited by W. S. Hunter and R. R. Willoughby. Subscriptio[illegible] Monthly. 700 pages annually. Founded 1927. Abstracts of psych[illegible] literature.

Journal of General Psychology—Worce[illegible] Mass.: Clark University Press.
Subscription $14.00 per year; $7.0[illegible] vol., 1000 pages ann. (2 vols.). Edited by Carl Murchinson. Foun[illegible]7.
Quarterly. Experimental, theoreti[illegible]ical, and historical psychology.

Journal of Social Psychology—Worces[illegible]ss.: Clark University Press.
Subscription $7.00. 500 pages an[illegible] Edited by John Dewey, Carl Murchison, and internati[illegible] co-o[illegible]g board. Quarterly. Political, racial, and differential ps[illegible]ology. [illegible]ded 1929.


INCHES
METRIC
C2399